CONTRACT NAS5-30350
Attachment 7

GSFC S-480-26.1

PERFORMANCE ASSURANCE REQUIREMENTS

FOR THE

NOAA-K, L, M, N, & N-prime

SATELLITES

Issued June 1988 for NOAA-KLM

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GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland

REVISION HISTORY

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Contract Award	07/88	Initial Release
88/131	08/2/93	3.4.3.1, TABLE 3-1, 3.4.3.2, 3.4.4.1, 3.4.5.1, 3.4.6.1

MOD No. 132 N/N-prime Mod Award	12/xx/94 Section(s) Changed	
Initial Release S-480-26.1	Document Reformated and Repaginated	
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	4.7	4.8
	4.8	4.9
	4.9	4.10
	4.10	4.11
	8.5.8	8.5.8.a
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136	03/01/95	3.4.3.1 -- Definitizes Mod 88/131
149	08/16/95	3.4.3.2
155	09/19/95	6.2.6

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1 GENERAL REQUIREMENTS

1.1 BASIS AND SCOPE OF THE REQUIREMENTS

This document incorporates the applicable portions of the National Aeronautics and Space Administration (NASA) Reliability and Quality Assurance Handbooks NHB 5300.4(1A) and (1B) and, in addition, contains other elements of performance assurance such as reviews, safety, functional and environmental testing, and contamination control.

1.2 GENERAL REQUIREMENTS

The contractor shall establish an organized program for demonstrating that the design meets the functional requirements, including specified margins, that the hardware has been manufactured properly and will operate properly in association with all other project components, and that the software meets design and mission requirements.

The contractor shall implement and maintain a performance assurance program that encompasses flight equipment, government furnished property, and spares. The program applies to all work accomplished by the contractor and his subcontractors and suppliers (also termed "contractor") who provide software, flight hardware, and support.

The performance assurance plan for the Advanced TIROS-N Aerospace Ground Equipment (ATNAGE) is to be in accordance with paragraph 8.24.

1.3 PERFORMANCE ASSURANCE IMPLEMENTATION PLAN

The Performance Assurance Implementation Plan (also termed the "Implementation Plan") describes the contractor's system for accomplishing the assurance activities in compliance with the requirements herein. The contractor shall prepare the Implementation Plan and submit it in accordance with Attachment 2 of the contract. The approved Plan and this document shall become part of the contract negotiated between the contractor and the Goddard Space Flight Center (GSFC) Tiros Project Office (also termed Tiros). If any inconsistencies between the approved Implementation Plan and this document become evident, this document shall take precedence, except where specific deviations were identified and approved before award of the contract.

The contractor is encouraged to make maximum use of his existing practices and procedures in complying with this document. Applicable practices and procedures shall be submitted with the Implementation Plan.

1.3.1 Preparation of the Implementation Plan

The Implementation Plan shall address each of the nine sections of this document and shall describe specifically and in detail how the requirements are to be accomplished. In addition, the Plan shall include:

a. An organization chart and defined responsibilities.

b. A matrix of the requirements, referencing the applicable paragraph numbers in the Plan versus the implementation procedures, instructions, and specifications.

c. A list of assurance services that may be procured, identifying the proposed subcontractor.

d. Copies of procedures and instructions referenced in the Plan. Revisions to these documents shall be submitted in accordance with Attachment 2 of the contract.

e. Identification of significant hardware items to be purchased, categorization of these items for assurance purposes, and a detailed description of the portions of this document to be imposed on each category.

1.4 USE OF PREVIOUSLY DESIGNED, FABRICATED, OR FLOWN HARDWARE

The contractor shall demonstrate that the proposed hardware will comply with the requirements of this document, as well as the performance requirements.

When previously designed, fabricated, or flown hardware is proposed for use on this project and is considered to have demonstrated compliance with the requirements of this document, the contractor shall submit substantiating documentation. The documents shall:

a. Compare each performance, design, and interface requirement for this project (as delineated in other documents related to this procurement) with the corresponding previous requirement. For any that do not comply, either describe what modification will be made to achieve compliance or provide a rationale and supporting information stating why the deviation is considered acceptable.

b. Compare each performance assurance requirement for this project (as delineated in this document) with the corresponding previous requirement. For any that do not comply, describe what will be done to achieve compliance or provide a rationale and supporting information stating why the deviation is considered acceptable. In addition, state how any modifications proposed as a result of paragraph 1.4a will be shown to comply with the performance assurance requirements of this document.

c. Compare the manufacturing information for the hardware proposed for this project with that for the previous hardware. As a minimum, this comparison shall include the name and location of the manufacturer, the date of manufacture, any design changes, any changes to parts or materials, any modification to packaging techniques, and any change to fabrication or assembly processes.

d. Describe all flight experience with the proposed hardware including, in particular, a description of all failures or anomalies, their cause, and any corrective action that was taken as a result.

Such documentation shall be submitted to Tiros with the proposal and updated in accordance with Attachment 2 of the contract.

1.5 MANAGEMENT OF THE ASSURANCE PROGRAM

The contractor shall implement a system for effective management control and audit of the assurance program. He shall assign responsibility and authority for managing the assurance activities to individuals who have unimpeded access to higher management.

1.6 PERFORMANCE ASSURANCE STATUS REPORT

Each month a Performance Assurance Status Report shall be prepared that contains the status of the assurance activities, any deficiencies that could affect the end-item product, and the intended corrective action. The report shall cover the following appropriate items, as well as those called for in the individual sections of this document:

a. Significant assurance problems

b. Key organization and personnel changes

c. Unresolved hazards (safety program)

d. Significant inspection and test activities

e. Status of procurements and subcontractor performance assurance programs

f. Summary of audit reports

The Performance Assurance Status Report shall be submitted to Tiros in accordance with Attachment 2 of the contract.

1.7 SURVEILLANCE OF THE CONTRACTOR

The work, activities, and operations of the contractor, subcontractors, and suppliers shall be subject to evaluation, review, survey, and inspection by government-designated representatives from the GSFC project office, the Government Inspection Agency (GIA), or an independent assurance contractor (IAC). GSFC will delegate comprehensive and specific in-plant responsibilities and authority to these agencies in a letter of delegation or the GSFC contract with the IAC.

The contractor shall provide the government representative with the documents (including an approved Implementation Plan), records, equipment, and working areas within his facilities that the government representative requires for performing his overview activities.

Where contractor source inspection is used, the contractor shall provide a list of duties, responsibilities, and authorities of his at-source quality assurance (QA) personnel to the designated government quality representative at the contractor's facility. When both contractor and government source inspection personnel are used at any supplier's facility, the listing shall also be provided to the Government source representative at that facility upon issuance of the procurement.

1.8 GENERAL PROCUREMENT REQUIREMENTS

The contractor is responsible for ensuring that all contractor- purchased products and services meet the requirements of this specification.

1.8.1 Selection of Sources

When the contractor selects procurement sources, he shall assign assurance personnel to participate in the selection. Performance history, receiving inspection and test results, supplier rating system, and survey results shall be used to assess the capability of each potential procurement source in producing reliable products.

1.8.2 Requirements on Subcontractor and Suppliers

The contractor shall ensure that his procurement documents impose the applicable requirements of this document on subcontractors and other suppliers. The subcontractor and other suppliers shall in turn impose the requirements on their procurement sources.

1.9 AUDITS

The contractor shall conduct audits of his assurance activities and those of his subcontractors and suppliers to ensure compliance with appropriate provisions of this document, the Implementation Plan, and the provisions of the procurement document. To verify the effectiveness of the performance assurance systems, each audit shall include an examination of operations and documents, as well as an examination of articles and materials. The audit program shall be defined in the Implementation Plan.

1.9.1 Subcontractor and Supplier Audits

The contractor shall perform audits of his subcontractors and suppliers as necessary to ensure compliance with the subcontractor performance assurance requirements. The contractor's schedule and conduct of the audits shall be based upon the following:

a. Criticality of items being procured, those items identified by failure mode, effects, and criticality analyses, or information from trend analyses

b. Known problems or difficulties

c. Supplier quality history

d. Remaining period of supplier performance

The audit program for the subcontractors and suppliers shall be defined in the Implementation Plan.

1.9.2 Audit Reports

A documented account of audits shall be submitted to management with recommendations for correcting any deficiencies. Management shall take action to ensure correction of any deficiencies and shall conduct reviews to ensure that the corrections have been made.

Audit reports shall be made available to the government representative on request, and a summary of the audit reports shall be submitted to GSFC as part of the Performance Assurance Status Report (paragraph 1.6).

1.10 APPLICABLE DOCUMENTS (APPENDIX A)

To the extent referenced herein, applicable portions of the documents and revision levels listed in Appendix A form a part of this document.

1.11 GLOSSARY (APPENDIX B)

Appendix B lists definitions that are needed for a common understanding of terms as applied in this document.

1.12 DELIVERABLE FLIGHT ASSURANCE DATA AND GSFC RESPONSE

Deliverable data are specified in the contract. Attachment 2 of the contract lists the deliverable data and cites when the data shall be delivered and whether it is required for Tiros approval, review, or information.

2. ASSURANCE REVIEW REQUIREMENTS

2.1 GENERAL REQUIREMENTS

The contractor shall for new or modified elements of the program conduct a program of planned, scheduled, and documented reviews covering the flight hardware, flight software, operations ground equipment, and ground data processing for which the contractor has responsibility. The contractor's program shall include reviews at the component and subsystem level as required by paragraph 2.5, and support to reviews conducted by a Tiros Flight Assurance Review Team. These reviews of the contractor's work shall occur at specified times during the course of the program and shall serve the purpose of both contractor technical management and government assessment.

2.2 Tiros FLIGHT ASSURANCE REVIEW REQUIREMENTS

The contractor shall support a series of comprehensive design reviews that are conducted by a Tiros Flight Assurance Review Team. For each specified review, the contractor shall:

a. Develop and organize material for oral presentation to the Tiros review team. Copies of visual aids and other supporting material that are pertinent to the review shall be submitted in accordance with Attachment 2 of the contract.

b. Support splinter review meetings that result from the major review.

c. Produce written responses to recommendations and action items that result from the review.

2.3 TIROS FLIGHT ASSURANCE REVIEW PROGRAM

The Flight Assurance Review Program shall consist of individual reviews as described in paragraphs 2.3a through f.

a. System Concept Review (SCR)--This review is keyed to the end of the definition study phase and will evaluate the design approaches and the operational concepts of new or changed elements of the program.

b. Preliminary Design Review (PDR)--For new or modified elements of the program, this review usually occurs early in the design phase but prior to manufacture of engineering hardware. Where applicable, it should include the results of test bedding and breadboard testing.

c. Critical Design Review (CDR)--For new or modified elements of the program, this review usually occurs after the design has been frozen but prior to the start of manufacture of flight components. It will emphasize implementations of design as well as test plans for flight systems including the results of engineering model testing.

d. Pre-environmental Review (PER)--This review occurs prior to the start of environmental testing of the protoflight or flight system. The primary purpose of this review is to establish the readiness of the system for test and evaluate the environmental test plans.

e. Preshipment Review--This review will take place prior to shipment of the flight spacecraft to the launch range, and it will concentrate on system performance during acceptance testing.

f. Flight Readiness Review (FRR)--This review is to assess the overall readiness of the total system to support the flight objectives of the mission.

2.4 SYSTEM SAFETY

System safety shall be an agenda item for each review in the program and, as such, shall serve to support the total system safety review program specified in paragraph 4.8.

2.5 CONTRACTOR REVIEW REQUIREMENTS

The contractor shall conduct a program of reviews at the component level for new or changed boxes. The program shall consist of a PDR and a CDR at each box and subassembly level and at lower levels of assembly when required for new or changed boxes. Packaging reviews shall be conducted on all new electrical, electronic, and electromechanical (EEE) components in the flight system. Each packaging review shall evaluate the ability of the packaging concept and design to perform successfully during testing and under operating and environmental conditions of the mission. These reviews shall be conducted in accordance with GSFC S-311-98A, "Guidelines for Conducting a Packaging Review" (see Appendix A). In addition to these packaging guidelines, the reviews shall specifically address the following:

a. Placement, mounting, and interconnection of each EEE part or circuit board or substrate

b. Structural support and thermal accommodation of the boards and substrates and their interconnections in the component design

c. Provisions for protection of the parts and ease of inspection

Component level CDRs and PDRs shall include report of the pertinent parts stress analyses required by paragraph 7.3.2 and reports of the corresponding component packaging reviews including the results of associated tests and analyses.

Contractor personnel who are not directly responsible for hardware design shall conduct these reviews. Tiros reserves the right to attend the reviews and requires notification at least 10 working days before each review. The results of the reviews shall be documented, and a summary of each review shall be included in the Performance Assurance Status Report (paragraph 1.6). On request, the review data shall be made available to Tiros.

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3 PERFORMANCE VERIFICATION REQUIREMENTS

3.1 GENERAL REQUIREMENTS

A Performance Verification Program shall be conducted to ensure that the spacecraft changes meet the specified mission requirements. The program consists of a series of functional demonstrations, analytical investigations, physical property measurements, and environmental tests that simulate the environments encountered during prelaunch, launch, and in-orbit flight. All protoflight hardware shall undergo qualification tests to demonstrate compliance with the verification requirements of this section. In addition, all other hardware shall undergo acceptance testing in accordance with the verification requirements of this section unless specific modifications are permitted in a subparagraph entitled "Acceptance Requirements."

The Performance Verification Program begins with functional testing of assemblies, continues through the functional and environmental testing at the component and spacecraft levels of assembly, and concludes with the testing of the entire operational system.

A total Performance Verification Program requires the demonstration and verification of supporting components and equipment, such as flight software and ground-test hardware and software. The following sections concentrate on flight hardware.

3.1.1 System Safety Considerations

Certain additional activities (not identified in this section) that are needed to satisfy the safety requirements of Section 4 may best be accomplished during the Performance Verification Program. It is therefore recommended that, to achieve cost and scheduling benefits, the Performance and Safety Verification Programs be closely coordinated.

3.2 DOCUMENTATION REQUIREMENTS

The management approach for accomplishing the Performance Verification Program shall be described in Section 3 of the Performance Assurance Implementation Plan (paragraph 1.3). In addition, the following specifications, plans, procedures, and reports are required for defining the technical aspects of the Performance Verification Program. The verification plan is required first, followed by a detailed specification, followed by detailed procedures at the time of need.

3.2.1 Verification Plan

A Verification Plan shall be prepared that defines the tests and analyses that collectively demonstrate that the hardware complies with Sections 3.3 through 3.7 of this document. The Verification Plan shall provide the overall approach to accomplishing the verification program. For each test, it shall include the level of assembly, configuration of the item, objectives, facilities, instrumentation, safety considerations, contamination control, test phases and profiles, necessary functional operations, personnel responsibilities, and requirements for procedures and reports. It shall also define a rationale for retest determination that does not invalidate previous verification activities. When appropriate, the interaction of the test and analysis activity shall be described.

For each analysis activity, the plan shall include objectives, a description of the mathematical model, assumptions on which the models will be based, required output, criteria for assessing the acceptability of the results, the interaction with related test activity, if any, and requirements for reports.

As an adjunct to the Verification Plan, a test matrix shall be prepared that summarizes all tests that will be performed on each component and the spacecraft.

The Verification Plan shall be delivered to Tiros in preliminary form with the proposal and in final form in accordance

with Attachment 2 of the contract.

3.2.2 Verification Specification

A Verification Specification shall be prepared that stipulates the specific environmental parameters associated with each of the tests and analyses required by the Verification Plan.

In defining quantitative environmental parameters under which the hardware elements must meet their performance requirements, the Verification Specification shall consider things such as spacecraft peculiarities.

The Verification Specification shall be delivered to Tiros in preliminary form with the proposal and in final form in accordance with Attachment 2 of the contract.

3.2.3 Verification Procedures

For each functional and environmental test activity conducted at the component, subsystem, and payload levels, Verification Procedures shall be prepared that describe how each test activity contained in the Verification Specification and Verification Plan will be implemented.

Verification Procedures at the subsystem and spacecraft levels shall be submitted to Tiros in accordance with Attachment 2 of the contract. The component procedure shall be made available at the contractor's facilities for Tiros review.

3.2.3.1 Control of Unscheduled Activities During Verification

An operational procedure shall be established for controlling, documenting, and approving all activities that are not part of an approved procedure. The contractor shall be alert to the hazard potential of last-minute changes and shall institute controls at appropriate management levels for preventing accident or injury or hardware damage. Such control shall include appropriate real-time decision making mechanisms to expedite continuation (or suspension) of testing after malfunction, with documented rationale. The control procedure shall be contained in the Performance Assurance Implementation Plan (paragraph 1.3) and shall be referenced in each Verification Procedure.

3.2.4 Verification Reports

After completion of each component and spacecraft verification activity, a report shall be submitted in accordance with Attachment 2 of the contract. The Verification Report shall be issued after successful completion of Flight Acceptance Test for each component. It shall indicate on the front sheet all the types of tests to which the unit was subjected. The forms shown in Figure 3-1 shall be used. The table shall show date and starting time of each type test, indicated by a block in the unit TP Test Flow Diagram, starting with Post Pot Electrical Performance Tests and all Special Tests covered by FARs after Acceptance Test completion.

TDR numbers shall be listed in the table to the right of the test event entry to which they apply. A reproduced copy of the Anomaly Summary (from the ABPL sheet and a reproduced copy of the Operating Time and Cycle Summary sheets from the Document Folder) shall be attached to the Verification Report.

In addition, as-run verification procedures, as well as all test and analysis data, shall be made available for review at the contractor's facility on request. Copies of selected data sets shall also be made available to Tiros.

Figure 3-1a Sample Test Report (Sheet 1 of 2)

Figure 3-1b Sample Test Report (Sheet 2 of 2)

3.3 ELECTRICAL FUNCTION TEST REQUIREMENTS

3.3.1 Electrical Interface Tests

Before the integration of an assembly or component into the next higher hardware assembly, electrical interface tests shall be performed to verify that all interface signals are within acceptable limits of applicable performance specifications.

After integration, the electrical harnessing shall be tested to verify that electrical signals are properly routed. All such testing, as well as the accompanying integration activities, shall be performed in an area that conforms to the cleanliness criteria developed in response to Section 9.

3.3.2 Performance Tests

3.3.2.1 Comprehensive Performance Tests

When all assemblies, components, and the spacecraft are integrated, a comprehensive performance test (CPT) shall be conducted on each hardware element. When environmental testing is performed at a given level of assembly, additional comprehenive performance tests shall be conducted during the hot and cold extremes of the temperature or thermalvacuum test and at the conclusion of the environmental test sequence, as well as at other times that shall be defined in the Verification Specification. The comprehensive performance test shall be a detailed demonstration that the hardware meets its performance requirements within allowable tolerances. The test shall demonstrate that all redundant circuitry is operating and that the hardware is performing satisfactorily in all operational modes within practical limits of cost, schedule, and environmental simulation capabilities. The initial CPT shall serve as a baseline against which the results of all later CPTs can be readily compared. At the spacecraft level, the comprehensive performance test shall demonstrate that, when known stimuli are applied, the spacecraft will produce the expected responses. At lower levels of assembly, the test shall demonstrate that, when appropriate stimuli are provided, internal performance is satisfactory and outputs are within acceptable limits.

3.3.2.2 Limited Performance Tests

Limited performance tests shall be performed before, during, and after environmental tests, as appropriate, to demonstrate that the environmental tests have not degraded the functional capability of the hardware. Limited performance tests shall also be used in cases for which comprehensive performance testing is not warranted or not practicable. Specific times at which limited performance tests will be performed shall be defined in the Verification Specification. Limited performance tests shall demonstrate that the performance of selected hardware is within acceptable limits.

3.3.2.3 Limited Life Electrical Elements

A life test program shall be considered for electrical elements that have limited lifetimes. The Verification Plan shall address the life test program: identifying the electrical elements that require such testing, describing the test hardware that will be used, and the test methods that will be employed. Limited life electrical items shall be included in the Limited Life List as required in Section 7 of this document.

3.3.2.4 Trouble-free Performance Testing

At the time of launch, spacecrafts shall have demonstrated minimum reliability acceptability by trouble-free performance testing for at least the last 100 hours of testing. Trouble-free operation during the thermal-vacuum test exposure may be included as part of the demonstration. Major hardware changes during or after the verification program shall invalidate previous demonstration.

3.4 STRUCTURAL AND MECHANICAL REQUIREMENTS

3.4.1 General Requirements

The contractor shall demonstrate compliance with structural and mechanical requirements with a series of interdependent test and analysis activities. The demonstrations shall verify design and specified factors of safety, ensure interface compatibility, and acceptable workmanship.

3.4.2 Requirements Summary

Table 3-1 specifies the required structural and mechanical verification activities. When planning the tests and analyses, the contractor shall consider all expected environments, including those of structural loads, vibroacoustics, mechanical shock, and pressure profiles and shall verify the mass properties and mechanical functioning.

The program outlined in Table 3-1 assumes that the design of the spacecraft is sufficiently modularized to permit realistic environmental exposures at the component level. When that is not possible, compliance with the componentrequirements shall be accomplished atthe spacecraft level of assembly. Note that each of the components and the spacecraft shall be verified for each of the requirements identified in Table 3-1.

3.4.3 Structural Loads

3.4.3.1 Design Qualification (Protoflight NOAA-K)

Verification for the structural-load environment shall be accomplished by a combination of test and analysis. The NOAA-M structure will be exposed to a protoflight level static loads test to verify that the analytical model of the spacecraft primary structure adequately represents its dynamic characteristics. The test verified model shall then be used to predict the maximum expected load for each potentially critical loading condition, including handling, transportation, and vibroacoustic effects during liftoff. The maximum loads that result from the analysis shall define the kimit loads.

The usual method of qualifying adequate strength is to apply a set of loads equal to 1.25 times the limit loads after which the hardware must be capable of meeting its performance criteria and exhibit no permanent deformation.

The strength qualification test (protoflight) must be accompanied by a stress analysis that predicts that ultimate failure will not occur at loads equal to 1.40 times the limit load. Limit load is defined as expected flight load.

If analysis is used instead of test, Specification paragraph 4.2.1.3 shall be applicable.

When composite materials are used in the structure, analytic strength verification may not be used. The wider ranges of strength associated with composite structures must be taken into account by additional demonstrations, such as development tests, proof tests, and larger design factors. The use of materials that are susceptible to brittle fracture or stress-corrosion cracking require the development of and strict adherence to special procedures to prevent problems.

3.4.3.2 Acceptance (Flight) Requirements

NOAA-L , -M, -N, and -N-prime spacecraft shall be subjected to limit (expected flight) loads via a sine test, as described in section 4.4.4 of the specification (GSFC-S-480-25.1). Also, structural elements fabricated of composite material shall be proof-tested to the limit (expected flight) load.

Table 3-1 Structural and Mechanical Requirements

Requirement	Level of Assembly	
	Spacecraft	Component
Structural Loads	T^2	T^2 or A
Structural Reliability (Sine Test)	T	T^1
Vibroacoustics	-	-
Acoustics	T	T^1
Random Vibration	-	T
Mechanical Shock	T	-
Mechanical Function	A, T	-
Pressure Profile	-	-
Mass Properties	A, M	-

M - Measurement.

T - Test required.

T^1 - Test must be performed if indicated by analysis or other considerations.

A - Analysis required.

T^2 - Test required for new or modified design. (Static load, sine burst, etc.)

3.4.3.3 NDE

Critical metallic structural elements shall be subjected to Nondestructive Evaluation (NDE) per paragraph 6.2.7.

3.4.4 Vibroacoustics

3.4.4.1 Design Qualification (Protoflight)

For the vibroacoustics environments, limit levels are equal to the maximum expected flight environment as specified in S-480-25.1. The design qualification (protoflight) level is defined as the limit plus 3 dB. When random vibration levels are determined, responses to the acoustic inputs plus the effects of vibration transmitted through the structure shall be considered. As a minimum, component random vibration levels shall be sufficient to demonstrate acceptable workmanship. For qualification of hardware, tests shall be conducted at design qualification (protoflight) levels. The spacecraft in the flight configuration shall be subjected to an acoustics test.

3.4.4.2 Acceptance Requirements

For the acceptance testing of previously qualified hardware, testing shall consist of a minimum of three axis random testing on all components and acoustics testing on the spacecraft at the maximum expected flight levels.

3.4.5 Mechanical Shock

3.4.5.1 Design Qualification (Protoflight)

Both self-induced and externally induced shocks shall be considered in defining the mechanical shock environment. All components shall be exposed to all self-induced shocks by actuation of the shock-producing devices. Each device must be actuated a minimum of two times in order to account for the scatter associated with different actuations of the same device.

For pyrotechnically operated propulsion valves that are difficult to replace, it shall not be necessary to accomplish verification by operation of these devices if the following criteria are met: (1) the valves are physically mounted on structure which is relatively remote from electronics devices and (2) it can be shown analytically or by test that shock produced by operation of the pyro valves are no greater at electronic equipment mounting locations than other self-induced or externally induced shocks.

In addition, when the most severe shock is externally induced, a suitable simulation of that shock shall be applied twice at the component interface. The design qualification level shall equal the maximum expected value at the component interface. The spacecraft shall be subjected to the firing of all pyrotechnic devices while in the flight configuration.

3.4.5.2 Acceptance (Flight) Requirements

Mechanical shock test requirements do not apply to the acceptance testing of previously qualified hardware.

3.4.6 Mechanical Function

3.4.6.1 Design Qualification (Protoflight)

A kinematic analysis of all new spacecraft mechanical operations is required: (a) to ensure that each mechanism can perform satisfactorily and has adequate margins under worst-case conditions, (b) to ensure that satisfactory clearances exist for both the stowed and operational configurations, as well as during any mechanical operation, and (c) to ensure that all mechanical elements are capable of withstanding the worst-case loads that may be encountered.

Spacecraft operational tests are required to demonstrate that the installation of each mechanical device is correct and that no problems exist that will prevent proper operation of the mechanism during mission life.

Component design qualification (protoflight) tests are required for each new mechanical operation. To establish that functioning is proper for normal operations, the nominal test shall be conducted at the most probable conditions expected during normal flight. The levels of the tests shall demonstrate margins beyond the nominal conditions by considering adverse interaction of potential extremes of parameters such as temperature, friction, spring forces, stiffness of electrical cabling or thermal insulation, and, when applicable, spin rate. Test conditions shall not be selected arbitrarily, but shall take into account uncertainties of operation, strength, and test. As a minimum, however, successful operation at temperature extremes 10°C beyond the range of expected flight temperatures shall be demonstrated by test or analysis.

3.4.6.2 Acceptance (Flight) Requirements

Verification testing of spacecraft mechanical operation is required only at the nominal condition for the acceptance of previously qualified hardware.

3.4.6.3 Life Testing

A life-test program shall be considered for new or modified mechanical elements that move repetitiously as part of their normal function and whose useful lifetime must be determined in order to verify their adequacy for the mission. In the Verification Specification and Verification Plan, the contractor shall address the life-test program, identify the mechanical elements that require such testing, and describe the test hardware that will be used and the test methods that will be employed. For items for which it is determined that life testing is not required, the rationale for such determination shall be provided along with a description of the analyses that will be conducted during the course of the program to verify the validity of such a determination.

3.4.7 Pressure Profile

3.4.7.1 Verification

The need for a pressure profile test shall be assessed for all components. A verification test shall be performed if analysis does not indicate a positive margin at loads equal to twice those induced by the maximum expected pressure differential during launch. If a test is required, the limit pressure profile is determined by the predicted pressure/time profile for the nominal trajectory of the particular mission. Because pressure-induced loads vary with the square of the rate of change, the verification pressure profile is determined by multiplying the predicted pressure rate of change by a factor of 1.12 (the square root of 1.25, the required verification factor on load).

3.4.7.2 Acceptance Requirements

Pressure profile test requirements do not apply for the acceptance testing of previously qualified hardware.

3.4.8 Mass Properties

Because hardware mass property requirements are mission-dependent, they shall be determined on a case-by-case basis. The mass properties program shall include an analytic assessment of the spacecraft's ability to comply with the mission requirements, supplemented as necessary by measurement.

3.5 ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS

3.5.1 General Requirements

The electromagnetic characteristics of hardware shall be such that:

a. The spacecraft and its elements shall not generate Electromagnetic Interference (EMI) that could adversely affect its own subsystems and components.

b. The spacecraft and its components shall not be susceptible to emissions that could adversely affect their safety and performance, regardless of whether the emissions are self-generated or are derived from other sources as previously experienced on the TIROS Program.

3.5.2 Specific Requirements

The contractor shall demonstrate compliance with the requirements of test procedure TP-EMI-2297294.

3.5.3 Magnetic Properties

The contractor shall maintain magnetic properties control to the extent necessary to meet GSFC-S-480-25.1.

3.6 VACUUM, THERMAL, AND HUMIDITY REQUIREMENTS

3.6.1 General Requirements

The following spacecraft (or spacecraft equipment) capabilities shall be demonstrated to satisfy the vacuum, thermal, and humidity requirements:

a. The spacecraft shall perform satisfactorily in the vacuum and thermal environment of space.

b. The thermal design and the thermal control system shall maintain the affected hardware within the established mission thermal limits.

c. The hardware shall withstand, as necessary, the temperature and humidity conditions of transportation, storage, launch and operational use.

3.6.2 Requirements Summary

Table 3-2 summarizes the tests and analyses that collectively will serve to fulfill the general requirements of paragraph 3.6.1. Tests noted in the table may require supporting analyses and vice versa. The contractor shall determine the order in which the demonstrations are conducted and shall specify this order in the Verification Specification (paragraph 3.2.1).

3.6.3 Thermal-Vacuum

3.6.3.1 General Requirements

The thermal-vacuum test shall demonstrate the ability of the hardware to perform satisfactorily in functional modes representative of the mission in vacuum at the nominal mission operating temperatures, at a temperature margin of $\pm 10°C$ beyond the mission allowable temperature limits for hardware utilizing passive thermal control, $\pm 5°C$ for hardware utilizing active thermal control, and during temperature transitions. In the case of spacecraft-level tests, the 10°C margin shall be achieved within the constraints of cost-effectiveness. During spacecraft level tests, temperature

Table 3-2 Vacuum, Thermal, and Humidity Requirements

Requirement	Level of Assembly	
	Spacecraft or Highest Practicable Level of Assembly	Component
Thermal Vacuum	T	T
Thermal Balance	T/A	A
Temperature/Humidity (Transportation and Storage)	A	A
Leakage [1]	T	T

[1] Hardware that passes this test at a lower level of assembly does not need to be retested at a higher level unless there is reason to suspect its integrity.

T Test required.

A Analysis required; tests may be required to substantiate the analysis.

T/A Test is highly desirable; analysis is mandatory.

limits may vary becauseof differing thermal conditions on opposing sides of the spacecraft.

Components and subsystems shall be subjected to a minimum of eight thermal vacuum temperature cycles. These eight cycles shall include a minimum of two thermal-vacuum temperature cycles performed at the spacecraft level. Components and subsystems shall be exposed for a minimum of four hours at each temperature extreme. Spacecraft shall be exposed for a minimum of 16 hours at each temperature extreme. Component turn-on capability shall be demonstrated under vacuum at least twice at the low and high temperatures (as applicable). The ability to function through the voltage breakdown region shall be demonstratedif applicable. Components that are determined to be insensitive to vacuum effects may be temperature cycled and hot and cold started at normal room pressure in an air or gaseous nitrogen environment; components that are so tested shall be subjected to a test of four thermal cycles. All components that will be used for flight shall be exposed to a minimum of eight temperature cycles either at the component level or at the combined component and spacecraft levels of assembly. These cycles are considered cumulative.

Temperature excursions during cycling of components shall be large enough to detect latent defects in workmanship. Components shall be exposed for a minimum of 4 hours at each extreme of each temperature cycle.

During the cycling, the hardware shall be operating and its performance shall be monitored. Outgassing procedures that are found to be necessary (see Section 9) shall be made part of the thermal-vacuum test operations.

3.6.3.2 Acceptance Requirements

The thermal-vacuum test shall be designed to produce the temperature extremes expected in orbit as a minimum.

3.6.3.3 Additional Report Requirements

The thermal-vacuum verification reports shall include actual achieved test temperatures and pretest predicted temperatures. A detailed explanation shall be provided for any cases that differ by more than 5°C.

3.6.4 Thermal Balance

3.6.4.1 Verification

This test or analysis shall demonstrate the validity of the thermal design and the ability of the thermal control system to maintain the hardware within the Mission Allowable Temperature Limits for a new or modified design.

The thermal design shall be validated with an analytical model hat is confirmed by tests conducted on a thermal model or the flight hardware. The capability of the thermal control system shall be demonstrated in the same manner. If the flight hardware is not used in the test of the control system, verification of critical thermal properties (such as those of the thermal control coatings) shall be performed to demonstrate similarity between the item tested and the flight hardware. Although it is desirable to perform the test on a complete spacecraft, it may be impractical to do so; therefore, the demonstration may be accomplished by combining test and analysis.

3.6.4.2 Additional Report Requirements

The thermal balance verification reports shall include listings of pretest predicted temperatures, actual achieved test temperatures, items whose test temperatures lie outside the Mission Allowable Temperature Limits, and pretest predicted temperatures that lie within 5°C of the actual achieved test temperatures. It shall also contain a description of those nodal model changes or test boundary changes that are or were necessary for obtaining a correlation of actual test conditions with post-test predictions based upon these changes. Special emphasis shall be given to any items that cannot be reasonably shown to have a correlation between predictions and actual test conditions to within 5°C.

3.6.5 Temperature/Humidity (Transportation and Storage)

3.6.5.1 Verification

This analysis and, when necessary, test shall demonstrate that flight hardware that is not maintained in a controlled temperature/humidity environment to within demonstrated acceptable limits will perform satisfactorily after (or, if required, during) exposure to the uncontrolled environment.

The test shall include exposure of the hardware to the following extremes of temperatures and humidities: 10°C and 10 percent relative humidity or (but not greater than 95 percent RH) higher and lower than those predicted for the transportation and storage environments. The exposure at each extreme shall be for a period of 6 hours.

3.6.5.2 Acceptance Requirements

The temperature extremes shall be at least equivalent to that expected in orbit.

3.6.6 Leakage

This test shall demonstrate that leakage rates of sealed hardware are within the prescribed mission limits.

Leakage rates shall be checked both before and after stress-inducing portions of the verification program to disclose any anomalies. The final check may be conducted during the final thermal-vacuum test.

Checks at the spacecraft level should include only those items that have not demonstrated satisfactory performance at the component level or are not fully assembled until the higher levels of integration.

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4. SYSTEM SAFETY REQUIREMENTS

4.1 GENERAL REQUIREMENTS

The contractor shall plan and conduct a system safety program that:

a. Provides for the identification and control of hazards to personnel, facilities, support equipment, and mission hardware and software during all stages of project development. The plan shall also consider hazards in the flight hardware and software and associated support equipment that may affect the launch vehicle.

b. Satisfies the applicable guidelines, constraints, and requirements stated in the following documents (Appendix A):

(1) WSMCR 127-1, Western Space and Missile Center Safety Requirements, Range Safety Regulation, 15 May 1985.

(2) MIL-STD-1574A, System Safety Program for Space and Missile Systems, 15 August 1979.

c. Interfaces effectively with the industrial safety requirements of the contract and the contractor's existing safety organization.

4.2 SYSTEM SAFETY PROGRAM PLAN

The contractor shall prepare and submit a System Safety Implementation Plan (SSIP) that constitutes Section 4 of the Performance Assurance Implementation Plan (paragraph 1.3). Contractor documents referenced therein shall be submitted with the SSIP. This shall satisfy the requirement of submitting a System Safety Program Plan (SSPP) as detailed in MIL-STD-1574A.

The Plan shall describe the safety program requirements and implementation procedures that the contractor will invoke to ensure the identification and control of hazards to personnel and hardware during fabrication, tests, transportation, ground activities, and launch.

Typically, the Plan will address the following areas: system safety organization; interfaces, and responsibilities; internal and external safety review process; launch site safety; hazardous operation surveillance; accident investigation and reporting; safety audits; and monitoring of subcontracts. The following data shall also be provided: a milestone schedule of all major system safety activities that shows their time phasing with other related major activities; the procedure for reporting problems and activity status; and the industrial safety responsibilities, functions, and interfaces with the system safety program.

4.3 PROCEDURES

Each test, operating, or maintenance procedure, including computer controlled test sequences, shall be reviewed by the system safety manager or his designated representative. The review shall be based upon available data including the results of the operating hazard analysis. The review shall assure system safety precedence pertaining to system safety corrective actions is in accordance with paragraph 5.1.2. of MIL-STD-1574A.

4.4 ANALYSES

4.4.1 System Safety Checklist

Analyses shall be performed at component and system levels and shall be documented in accordance with MIL-STD-1574A to establish the applicable technical requirements of WSMCR 127-1. The analyses shall be performed or

updated for each review, and the completed forms shall become part of each safety data package.

4.4.2 Hazard Analyses

Early in the design phase and continuing through the contract effort, the contractor shall develop analyses for identifying the hazards associated with the mission operations, hardware, support equipment, related software, and their interfaces. The contractor shall take measures to minimize each significant identified hazard. Because analysis does not lend itself to detecting some types of hazards, a test for determining if a hazard exists may be necessary. Spacecraft ground operations and ground-support equipment shall also be analyzed. All hazards that affect personnel, launch vehicle hardware, or the spacecraft shall be identified. The analyses shall be updated as the hardware progresses through the stages of design, fabrication, test, transportation, and launch activities. The hazard reports shall be submitted as a part of a safety data package, prior to each design review, to document the identification, causes, controls, and verification methods for each hazard.

4.4.3 Operations Hazard Analyses

When the use of a facility or the performance of an activity could result in subjecting the payload or personnel to hazards, an Operations Hazard Analysis (OHA) shall be performed to identify the hazards and to document the requirements for either eliminating or adequately controlling each hazard. Operations that may require analyses including handling, transportation, functional tests, and environmental tests. A report of each OHA performed shall be submitted in accordance with Attachment 2 of the contract.

4.5 HAZARD CONTROL VERIFICATION

The control of all hazards shall be verified by test, analysis, inspection, similarity to previously qualified hardware, or any combination of these activities.

4.6 SAFETY-CRITICAL IDENTIFICATION LIST

a. Electrical/Electronic Systems -- Any operation involving the initial power-up or power-down of electrical/electronic system of a test facility, support equipment, or end item vehicle following initial installation, modification, or system repair; any power-up or power-down during initial checkout of integrated systems; or any operation of a battery powered electrical system of 28 volts or higher that does not have current-limiting devices.

b. Handling Operations -- Any operation involving the lifting, loading, packaging, or transporting of deliverable end items, subassemblies, major assemblies, delicate components, support equipment, dangerous materials, or fluids in which there is risk of damage to deliverable products or injury to operating personnel.

c. Material and Equipment Operations -- Any operation involving the use of toxic, explosive, flammable or corrosive materials, or radiation devices presenting a hazard potential.

d. Launch and Static Firing Operations -- Any operation conducted during prelaunch and countdown for launch operations.

e. RF Radiation -- Any operation during which RF energy is radiated through an antenna.

4.7 REVIEWS

The system safety manager shall attend all scheduled safety and design reviews. Presentation of system safety program status and safety problems having program impact shall be included in each program review. Presentation of hazard

analysis status, identification of hazards, and hazard reduction status, shall be included in each formal system review.

4.8 WAIVERS

When a specific safety requirement cannot be met, the contractor shall submit a waiver request to Tiros in accordance with Attachment 2 of the contract. Each waiver request shall address only one hazard and shall be submitted as soon as it is determined that one is required.

4.9 SAFETY DATA PACKAGE

The contractor shall submit to Tiros a safety data package that applies to the existent phase of the program at the time of the SCR, PDR, CDR and FRR. The contents of each package shall show status of compliance with the requirements of WSMCR 127-1 and shall be submitted in accordance with Attachment 2 of the contract. Each package should include an adequate technical and functional description of the spacecraft systems. Also provided shall be the system safety checklist, completed analyses results (as a minimum a preliminary hazards analysis and subsequent system hazard analysis as well as the OHA), and hazard reports.

4.10 LAUNCH COMPLEX SAFETY PLAN

The contractor shall submit to Tiros the appropriate data for inclusion in the Launch Complex Safety Plan in accordance with WSMCR 127-1, Chapter 5. The data will be submitted in accordance with Attachment 2 of the contract.

4.11 MISSILE SYSTEM GROUND SAFETY APPROVAL PACKAGE

The contractor shall submit to Tiros a Missile System Ground Safety Approval Package in accordance with WSMCR 127-1. The package will be submitted in accordance with Attachment 2 of the contract.

4.12 SAFETY LABELS AND PLACARDS

a. Conspicuous placards shall be mounted adjacent to any equipment that presents a hazard to personnel (e.g., from high voltage, heat, energetic particle radiation, toxic vapors, explosion, and RF radiation).

b. The weight capacity shall be indicated on stands, hoists, lifts, jacks, and similar weight-bearing equipment to prevent overloading.

c. Jacking and hoisting points on equipment shall be conspicuously and unambiguously labeled.

d. NO-STEP markings shall be provided, when necessary, to prevent injury to personnel or damage to equipment.

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5. PARTS CONTROL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

The contractor shall plan and conduct a parts control program in accordance with the requirements of this section. Under the program, only parts with acceptable, demonstrated performance and reliability shall be used. When possible, only standard parts shall be used.

5.2 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PARTS

5.2.1 Standard Parts

Standard parts are those parts designated as Grade 1 quality level parts in the GSFC Preferred Parts List (PPL) (Appendix A). The NASA Standard (EEE) Parts List (NSPL), MIL-STD-975, (Appendix A) is the prime source for NASA standard parts and is referenced by the PPL. Where differences in requirements exist between the NSPL and the PPL, the PPL takes precedence.

5.2.2 Nonstandard Parts Control

Any part not defined in paragraph 5.2.1 as standard is considered to be a nonstandard part and shall be subject to nonstandard parts control. Nonstandard parts shall be of a quality level consistent with that of the standard parts. Nonstandard parts whose acceptability has been verified and that are procured in accordance with requirements of the nearest applicable standard part may be used if prior approval is obtained. The rationale for selecting nonstandard parts and the supporting data attesting to the acceptability of the nonstandard parts for the application, both as to performance and reliability, shall be documented by the contractor. Contractor parts engineers shall approve the selection, application, evaluation, and acceptance criteria for nonstandard parts. The Nonstandard Parts Data Package shall be delivered to Tiros in accordance with Attachment 2 of the contract. The package shall include at least the items of information listed on GSFC Form 4-15, Nonstandard Parts Approval Request (Figures 5-1 and 5-2).

a. Parts Qualification--Nonstandard parts shall be qualified either by similarity, by existing data, or by test and inspection results.

b. Hybrid Microcircuits--Selection and approval of hybrid microcircuits that are not included in MIL-STD-975 (NASA) or the GSFC PPL shall comply with "General Requirements for Hybrid Microcircuits," GSFC Specification S-311-200 (Appendix A).

Any nonstandard part (NSPAR) that was previously approved by Metsat Tiros on the TIROS-N or ATN Series of spacecraft shall be approved for use on this project without processing a new NSPAR as soon as the contractor demonstrates that:

a. No changes have been made to the previously approved NSPAR SCD or vendor list.

b. All stipulations cited in the previous NSPAR approval have been implemented.

c. A search demonstrates that GIDEP ALERTS do not apply to any of those nonstandard parts (NSPARs).

The contractor shall identify by RAE and PG numbers all previously approved NSPAR's that are planned for use on this contract, including the assurances defined above, in accordance with Attachment 2 of the contract.

A summary of NSPAR activity within a 30-day period shall be included in the Performance Assurance Status Report (paragraph 1.6). All reports will list both the RAE and PG number for each NSPAR.

Figure 5-1 Nonstandard Parts Approval Request (GSFC Form 4-15)

Figure 5-2 Instructions for GSFC Form 4-15

5.2.3 Derating

EEE parts shall be applied in accordance with the derating guidelines of the GSFC PPL. Applicable derating guidelines of the NSPL are as specified in the PPL. A derating policy other than that specified shall require prior Tiros approval and shall be submitted as part of the Implementation Plan in accordance with Attachment 2 of the contract.

5.2.4 Parts Specifications

A standard EEE part shall be procured in accordance with the specification designated for the part. All other parts shall be procured in accordance with military, NASA, or contractor-controlled specifications prepared in accordance with MIL-STD-490, paragraphs 3.2, 3.3, and 4.0 (Appendix A).

The specifications or drawings shall fully identify the item being procured and shall include the necessary physical, electrical, environmental, and screening requirements, as well as the quality assurance provisions that control manufacture and acceptance. EEE parts screening requirements designated for the part shall specify test conditions, failure criteria, and lot-rejection criteria. The percent of defectives allowed in a screened lot shall be in accordance with that prescribed in the closest related military parts specification.

5.2.5 Rescreening

All JANTX and JANTXV transistors and diodes shall be subject to screening verification tests in accordance with the provisions of the GSFC PPL or MIL-STD-975. Other EEE parts, such as military "established reliability," need not be rescreened unless indicated by one of the following conditions:

a. Receiving inspection results

b. Destructive physical analysis results

c. Alerts, SPL, or PPL requirements

d. Other factors such as special design drift tolerance

5.2.6 Failure Analysis

Failure analysis is required to support the problem/failure reporting system. The analyses shall be performed by experienced personnel. The laboratory shall be equipped to analyze parts to the extent necessary to ensure understanding of the failure mode and cause. The failure analyses shall be available for review upon request.

5.2.7 Destructive Physical Analysis

An internal destructive examination shall be performed on a decapped sample of each manufacturing lot or lot-date-code of microcircuits, hybrid microcircuits, and semiconductors. Destructive physical analysis (DPA) tests, procedures, sample size, and criteria shall be as specified in GSFC Specification S-311-70 (Appendix A). A defect in any of the specimens as defined in S-311-70 shall be cause for lot rejection or a Material Review Board (MRB) action. Contractor DPA procedures and requirements may be used if they have been submitted to Tiros in accordance with Attachment 2 of the contract.

5.2.8 Common Buy Parts

For subcontractor components which are under common buy agreement to be like DMSP S-15 procured components, there will be differences in some parts screening from the KLMNN-prime requirements. These differences in screening shall be highlighted in NSPARs which will be sent to GSFC for approval.

5.3 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL DEVICES

Items that do not fall within the part types listed in MIL-STD-975 and the GSFC PPL and are not normally subject to further subdivision or disassembly without destruction of their designed use are considered to be Electrical, Electronic, and Electromechanical (EEE) devices.

EEE devices which were flown on the TIROS-N or ATN Series of spacecraft are authorized for use on this contract after identifying them on the Devices List described in paragraph 5.4 and demonstrating that the previous procurement specification and vendor were not changed and that no generic problems have been identified.
New EEE devices shall be subject to review and approval in accordance with the following procedure:

The contractor, after receiving a recommendation from the Reliability Parts Group, shall recommend a specific EEE device to Tiros. Tiros shall arrange to have the contractor provide the necessary specification documentation for Tiros and GSFC Parts Branch Review.

5.4 PARTS/DEVICES IDENTIFICATION LIST

An EEE parts and devices identification list (Figure 5-3), shall be maintained and updated as changes occur. The parts/devices shall be listed by component, along with part/device name, manufacturer, part/device number, specification, and quantity required. Nonstandard parts and devices shall be specifically identified. The Parts/Devices Identification List shall be submitted to Tiros in accordance with Attachment 2 of the contract.

5.5 RADIATION HARDNESS

Parts and devices shall be selected so as to meet the particular mission application in the expected radiation environment.

Figure 5-3 Parts/Devices Identification List

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6 MATERIALS AND PROCESSES CONTROL REQUIREMENTS

6.1 GENERAL REQUIREMENTS

The contractor shall implement a comprehensive Materials and Processes Program, beginning with the design stage of the hardware. The program shall help ensure the safety and success of the mission through the proper selection and treatment of the materials of construction.

6.2 SELECTION REQUIREMENTS

6.2.1 Conventional Applications

Selection of materials and processes shall be based upon past performance, available data, or current tests. The contractor shall be guided by the applicable documents listed in Appendix A.

6.2.2 Nonconventional Applications

Any use of a material for which there is a lack of aerospace experience shall be considered a nonconventional application. In that case, the material shall be verified for the desired application on the basis of similarity, analysis, test, inspection, existing data, or a combination of these methods.

6.2.3 Special Problem Areas

The contractor shall give special attention to problem areas such as radiation effects, stress/corrosion cracking, galvanic corrosion, hydrogen embrittlement, lubrication, contamination of cooled detectors, and weld-heat-affected zones. Critical high-strength fasteners and pressurized systems shall be reviewed from a fracture mechanics viewpoint before they are accepted for use.

6.2.4 Organic Materials

The outgassing characteristics of organic materials in vacuum shall be a prime consideration in selection. Only organic materials with a Total Mass Loss (TML)of less than 1.00 percent and a Collected Volatile Condensable Material (CVCM) of less than 0.10 percent when tested in accordance with ASTM E595-77 (Appendix A) shall be used.

6.2.5 Considerations in Process Selection

Manufacturing processes shall be carefully selected if they are the type that may substantially change a material's properties (e.g., heat treatment, welding, or chemical or metallic coatings). The objectives are to maintain the integrity of the materials and to avoid introducing property changes that could cause adverse effects.

6.2.6 Shelf-Life Controlled Items

In processes that involve polymeric materials whose uncured constituents have a limited shelf life (as indicated by the manufacturer's literature), some latitude will be granted for the use of date-coded expired materials if certain requirements are met. The contractor shall prove to Tiros by means of appropriate tests that the properties of the materials have not been compromised for their intended use. Fabricated items such as "O" rings that have out-of-date codes shall not be installed in flight hardware.

6.2.7 NDE Requirements

A nondestructive examination shall be performed on all critical areas of the metallic primary structure whose failure could cause loss of mission or danger to personnel. NDE shall consist of appropriate methods in accordance with MIL-I-6870 and shall be performed by inspectors who have been certified in accordance with MIL-STD-410. Critical areas shall be identified as those elements whose limit stress levels are greater than 87% of the material yield strength.

6.2.8 Satellite Peculiar Requirements

a. Corrosion Resistance -- Metals shall either be of a corrosion resistant type or suitably treated to resist corrosion. Protective methods and materials for cleaning, surface treatment, and application of finishes and protective coatings may be accomplished in accordance with MIL-F-7179E. Cadmium, zinc, or electro-deposited tin shall not be used as a finish.

b. Fungus Resistance -- Materials that are not nutrients for fungi shall be used to the greatest extent practicable. Refer to MIL-STD-810. Where nutrient material must be used outside of hermetically sealed containers, treating, packing, or other protective means shall be used to ensure no degradation of material. Refer to MIL-STD-454E for methods of treatment.

c. Polymer Materials -- Surfaces sensitive to contamination shall not be exposed to the outgassing products of polymeric materials, particularly when their temperature is above 40°C. Lubricants and polymeric materials shall not lose more than 1 percent of total weight after exposure for 24 hours at 125°C and 1.333×10^{-4} N/m^2, and no more than 0.1 percent of the material shall be volatile condensable material (VCM). Protective measures shall be provided for critical surfaces that are sensitive to the foregoing VCM requirement. Polymeric structures shall not fracture below -10°C.

d. Lubricants -- Lubricants shall not be exposed to outgassing products or other materials that are incompatible with the lubricant. The lubricants should be transparent in spacecraft mission wavelengths of interest except for the SBUV/2. The subsystem design shall provide adequate lubricant to meet the satellite design life requirements, including storage. The adequacy of the design to meet this requirement shall be demonstrated by test and analysis, except for units that have been previously qualified on the Tiros Program.

e. Dissimilar Metals -- The use of dissimilar metals in direct contact shall be avoided whenever possible. Where dissimilar metals are used, protection against electrolytic corrosion shall be applied in accordance with MIL-STD-454E, Req. 16.

f. Propellant Compatibility -- All spacecraft materials exposed to fumes, spillage, and combustion products of propellants shall be selected or protected to ensure compatibility with no degradation of physical or mechanical properties. These materials shall be rated with respect to corrosion rate, stress corrosion cracking, effect on fluid decomposition, and effect on the autogenous temperature. The propellant evaluation shall include hydrazine, the Titan II propellants, and carboxyl-terminated polybutadiene with ammonium perchlorate. Particular attention shall be given to the identity of the combustion products, pluming effects during launch, and analysis of various protection systems for the spacecraft hardware.

g. Cold Flow -- The use of nonmetallic materials that are subjected to cold flow under load shall be permitted only with designs that effectively restrain the material.

6.3 MATERIALS REVIEW

A contractor materials engineer shall review the applications of the proposed materials and processes on the basis of engineering drawings before approving their use. He shall also audit and consult with all subtier contractors and vendors to assure himself that the materials and processes are acceptable for the applications involved.

6.4 DOCUMENTATION

The following information shall be submitted to GSFC in accordance with Attachment 2 of the contract.

a. Data that supports unusual application.

b. Engineering drawings for materials application.

c. Inorganic Materials List--This list shall be prepared and documented on GSFC Form 18-59A (Figure 6-1).

d. Polymeric Materials List--This list shall be prepared and documented on GSFC Form 18-59B (Figure 6-2).

e. Lubrication List--This list shall be prepared and documented on GSFC Form 18-59C (Figure 6-3).

f. Materials Processes List--This list shall be prepared and documented on GSFC Form 18-59D (Figure 6-4).

The contractor may use his own system of reporting if it provides all the information requested by the GSFC forms.

Figure 6-1 GSFC Spacecraft Inorganic Materials List

Figure 6-2 GSFC Spacecraft Polymeric Materials List

Figure 6-3 GSFC Spacecraft Lubrication List

Figure 6-4 GSFC Spacecraft Materials Processes List

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7. RELIABILITY REQUIREMENTS

7.1 GENERAL REQUIREMENTS

The contractor shall plan and implement a Reliability Program that interacts with assurance programs for design, parts, materials, testing, and other space project activities. This section outlines the required elements of the Reliability Program. The contractor shall describe the methods for its accomplishment in the Implementation Plan (paragraph 1.3).

7.2 DESIGN ASSURANCE

7.2.1 Requirements

The contractor shall establish design criteria and shall standardize and control design practices. The designs shall be reviewed in accordance with paragraph 2.5 and be capable of:

a. Functioning properly during the required mission lifetime

b. Minimizing or eliminating potential sources of human-in- duced failures

c. Permitting ease of assembly, test, fault isolation, repair, servicing, and maintenance without compromising safety, reliability, quality, and performance

7.2.2 Contractor Support for Design Assurance

Contractor assurance personnel shall specifically ensure that:

a. The quality, reliability, safety, and maintainability considerations are factored into the design.

b. The design is capable of being inspected and tested and will facilitate repair.

c. The design is producible and repeatable.

d. The detailed design is in accordance with the controlling design criteria.

e. The performance, safety, and interface characteristics that require verification by analysis, inspection, and test are identified and reflected in appropriate lower-tier documentation.

f. All processes and operations in which uniform high quality cannot be ensured by inspection alone are identified and controls are established to ensure hardware integrity.

g. Applications of fasteners are in conformance with the requirements of paragraph 8.5.8.

7.2.3 Specifications, Drawings, and Test Procedures

7.2.3.1 Design Specifications

The contractor shall write a design specification for each item of hardware at the system, subsystem, and component levels. Each design specification shall identify the physical and functional requirements and interfaces of the specified item.

7.2.3.2 Specification, Drawing, and Test Procedure Reviews

The contractor's reliability organization shall review for concurrence all design specifications, drawings, and test procedures or shall ensure that they are independently reviewed before release. The review shall ensure that the documents cover all items of hardware at the appropriate levels, that each is complete in its contents, and that each is functionally and physically consistent with interfacing design specifications, drawings, and procedures. Reviews shall also be conducted for changes to the document.

7.3 RELIABILITY ANALYSES

Reliability analyses shall be performed on all new or modified components. The existing analyses for previously designed/flown hardware must be updated each time they are impacted. Where no preexisting analyses are available for previously flown hardware, analysis shall be performed limited to the redesign area and not the component as a whole. Each impact, major or minor, must be accounted for including changes of parts/devices from those used in previously flown hardware.

7.3.1 Failure Mode, Effects, and Criticality Analysis

A Failure Mode, Effects, and Criticality Analysis (FMECA) shall be performed to identify potential critical and catastrophic failures so that susceptibility to the failures and their effects can be eliminated from the system. A listing of all failure modes and the severity level of the failure's effects shall be provided. Catastrophic failures are defined as failures that prevent the achievement of mission success. Critical failures are defined as those that significantly degrade the achievement of mission success. The analysis shall be performed early in the design phase for all electrical and electromechanical flight hardware. The FMECA shall be updated at specific milestones and as required by design changes and other pertinent data or events.

The FMECA shall be conducted at the spacecraft/subsystem, subsystem/component, and the spacecraft/instrument interfaces. Potential component interface and/or instrument/spacecraft level critical and catastrophic failures shall be analyzed to the extent necessary to identify single elements that could cause the failures.

The FMECA shall be submitted to GSFC in accordance with Attachment 2 of the contract.

7.3.2 Parts and Devices Stress Analyses

Electrical, Electronic and Electromechanical (EEE) parts and devices, as applied in circuits within each component, shall be subjected to stress analyses for conformance with the derating guidelines of MIL-STD-975 and the GSFC PPL (paragraph 5.2.3). The analyses shall be performed at the most stressful part-level parameter values that can result from the specified performance and environmental requirements on the assembly or component. The analyses shall be performed in close coordination with the packaging reviews (paragraph 2.5) and shall be required input data for component-level design reviews (paragraph 2.5). The stress analyses shall be documented and updated as stated in Attachment 2 of the contract.

7.3.3 Worst-Case Analyses

Worst-case analyses shall be performed for critical parameters that are subject to variations that could degrade performance. Adequacy of margins in the design of electronic circuits, optics, and electromechanical and mechanical items shall be demonstrated by analyses and/or test. The analyses shall consider all parameters set at worst-case limits and worst-case environmental stresses for the parameter or operation being evaluated. The analyses shall be updated as part of the design changes. On request, both the analyses and updates shall be made available to Tiros.

7.4 LIMITED-LIFE ITEMS

Limited-life items shall be identified on a Limited-Life List and shall be submitted in accordance with Attachment 2 of the contract. The list shall include the expected life and the rationale for selecting each item. Limited-life items refers to materials, parts, or assemblies. As an example are batteries, pyrotechnics, and rubber products exhibiting properties which are deemed to be degradable from the time of manufacture, and which retain some or all of these properties regardless of use or application.

7.5 RELIABILITY OF GOVERNMENT-FURNISHED PROPERTY (GFP)

When the overall system includes components or subsystems furnished by Tiros, the contractor shall be responsible for obtaining from the Tiros Project Office adequate reliability data on the items. The data will be used for performing the FMECA. When the contractor's examination of the data or testing indicates that the reliability of GFP is inconsistent with the reliability requirements of the overall system, the Tiros Project Office shall be formally and promptly notified.

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8. QUALITY ASSURANCE REQUIREMENTS

8.1 GENERAL REQUIREMENTS

The contractor shall establish, document, and ensure compliance with design control requirements and quality criteria during all phases of contract work. In the Implementation Plan (paragraph 1.3), the contractor shall set forth his methods for meeting the QA requirements of the project during all of its phases. The plan shall ensure that controls are carried out according to schedule. Tiros shall be kept informed of the status of the QA program by the submittal of reports in accordance with paragraph 1.6.

8.2 SUPPORT OF DESIGN REVIEWS

Quality assurance personnel shall participate, as described in paragraph 7.2.2, in the contractor design reviews (paragraph 2.5).

8.3 DOCUMENT CHANGE CONTROL

The contractor shall ensure the control of all documents and changes thereto that affect the mission hardware and software. Quality assurance personnel shall ensure that documents and changes are controlled in accordance with the contractual configuration management requirements. The contractor shall ensure that the effectivity of documents and changes are clearly specified, changes are accomplished on affected articles, and changed articles are appropriately identified. Documents shall be kept current, and all fabrication, inspections, and tests shall be performed according to the applicable drawings and changes. The inspection record of the product shall indicate the change level with which it is in compliance.

The issue numbers of the drawings and specifications to which the particular hardware has been fabricated, inspected, and tested shall be documented as the as-built configuration. Evidence shall be provided of compliance with the as-built documentation as a basis for acceptance of the hardware. This information shall be submitted as part of the Acceptance Data Package (paragraph 8.24).

A contractor QA representative shall be a member of the contractor's board that controls configuration changes. The QA activities shall be defined in the Configuration Management Plan and shall be described in detail in the QA Plan; related portions of the plans shall be cross-referenced.

8.4 IDENTIFICATION AND TRACEABILITY

8.4.1 Requirements

The contractor shall maintain a product identification and tracking system. Each product shall be identified by a unique part or type number, consistent with the configuration management system for the contract. Where control of individual products or lots of products is required, date codes, lot numbers, serial numbers, or other identification shall be used as appropriate. Serial numbers and lot numbers shall be assigned in consecutive order.

The configuration management system shall be capable of retrieving the identification and serialization record at the subassembly level. Beginning at the subassembly level and continuing through the end product, the system shall be capable of tracing backward to the originating subassembly and forward to the location of the subassembly at any given level of process, assembly, or test. Identification and serialization data lower than that for subassemblies shall be maintained in the manufacturing and processing records and shall contain date code, lot numbers, and manufacturer of the item. The contractor is encouraged to make use of his existing identification and traceability system. Serial numbers of scrapped products shall not be reused.

8.4.2 Identification List

The contractor shall maintain an Identification List with reference to contractor-designed and supplier-designed products. The list shall indicate the part or type number and the group and individual identification. The list shall be a part of the configuration management system, and changes shall be in accordance with paragraph 8.3.

8.5 PROCUREMENT CONTROLS

The following detailed quality assurance requirements shall be included or referenced in the procurement documents, as applicable, in addition to those requirements selected in conformance with paragraph 1.8.2.

8.5.1 Product Changes

The supplier shall notify the contractor of proposed changes to products (including changes in design, fabrication methods or processes, and changes which may affect the quality or intended end use of the item). The supplier shall submit these changes to the contractor for processing in accordance with the contractor's Configuration Management Plan. When the contractor procures a proprietary item, the supplier shall also notify the contractor of those changes.

8.5.2 Purchased Raw Materials

Raw materials purchased by the contractor shall be accompanied by the results of chemical and physical tests or a certificate of compliance. When material is purchased for critical design applications, the supplier shall be required to furnish specimens for chemical and physical tests.

8.5.3 Raw Materials Used in Purchased Products

The supplier shall document and make available to the contractor on request the results of acceptance tests and analyses performed on raw materials.

8.5.4 Age Control and Limited-Life Products

Records shall be kept on products that have definite characteristics of quality degradation or drift with use or age. The records shall note the date, test time, or cycle when useful life was initiated, the life or cycles used, and the date and test time or cycle when useful life will be expended.

8.5.5 Inspection and Test Records

The contractor shall specify that the supplier maintain inspection and test records as evidence of inspection and test results. The contractor shall also specify records that are to be provided with the deliverable item.

8.5.6 Government Source Inspection (GSI)

When the government elects to perform inspection at a supplier's plant in accordance with paragraph 8.7, the following statement shall be included in the procurement document:

> "All work on this order is subject to inspection and test by the government at any time and place. The government quality representative who has been delegated NASA quality assurance functions on this procurement shall be notified immediately upon receipt of this order. The government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test."

8.5.7 Procurements That Do Not Require GSI

Procurements that do not require GSI shall include the following statement:

"The government has the right to inspect any or all of the work included in this order at the supplier's plant."

8.5.8 Weld Filler and Fastener Integrity

a. Weld rods, weld wire, and such procurements shall meet the requirements of MSFC-STD-655 (Appendix A).

b. Procurement, application, screening, inspection, and teset of fasteners, subsequent to the award of the NOAA-N/N-prime contract modification, shall conform with the requirements of GSFC Specification S-313-100.

8.5.9 Contractor QA Activity at Source

When contractor QA activity is required at a supplier's plant as determined by paragraph 8.8, the procurement document shall so indicate.

8.5.10 Resubmission of Nonconforming Articles or Materials

Nonconforming articles and materials returned to the supplier by the contractor and subsequently resubmitted by the supplier shall bear adequate identification of such resubmission. Reference shall be made to the contractor's nonconformance document, and evidence provided that the causes for the nonconformance have been corrected and actions have been taken to preclude recurrence.

8.6 REVIEW AND APPROVAL OF PROCUREMENT DOCUMENTS

Quality assurance personnel shall review and approve procurement documents before they are released to ensure that applicable requirements of this document are included. These reviews shall be documented.

8.7 GOVERNMENT SOURCE INSPECTION

The contractor shall forward procurement documents to the government representative for review so that he can ensure compliance with controlling documentation and determine the need for GSI. Such government inspection shall not replace contractor source inspection or relieve the contractor of his responsibilities for product reliability, quality, and safety.

8.8 CONTRACTOR SOURCE INSPECTION

The contractor shall perform source inspection at the subcontractor's or supplier's facilities when directed by the procurement documentation or when one or more of the following conditions exist:

a. In-process, end-item controls, or tests that are destructive in nature prevent the contractor from verifying quality in his plant.

b. It is not feasible or economical for the contractor to determine the quality of procured articles solely by inspections or tests performed at his plant.

c. Qualification tests are to be performed by the subcontractor or supplier.

d. Products are shipped directly from the source to user, bypassing the contractor's inspection facilities.

8.9 CONTRACTOR RECEIVING INSPECTION

A controlled, documented receiving inspection system that covers all purchased products is required to ensure compliance with procurement documents.

All procured products shall be processed through an incoming inspection and testing system prior to fabrication. Nondestructive Evaluation (NDE) may be used if controlled documentation and certified personnel are employed. The receiving-inspection system shall consist of the following:

a. Procured products shall indicate evidence of inspections and tests performed by the suppliers in accordance with the purchase requirements and shall be accompanied by the required data directly traceable to the products. The records shall give evidence of contractor and Government source inspection.

b. Inspections and tests shall be conducted in accordance with written procedures on selected characteristics of the products to verify their acceptability. Particular emphasis shall be placed on the selection of characteristics that have not been contractor-source inspected and those for which nonconformances are difficult to detect during subsequent inspection and test. Test results shall be compared on a sample basis with test results provided by the supplier. Disassembly shall be performed periodically for detailed verification when required by the procurement document or the procedures.

c. The supplier's age control and limited-life product records shall be updated to reflect the receiving inspection activity.

d. When required by procurement documents, chemical and physical tests shall be conducted on supplier-furnished specimens or on randomly selected samples of material having critical design applications. When acceptance is based upon a supplier's Certificate of Compliance (COC), chemical analyses or physical tests shall also be conducted on randomly selected samples from each lot of materials to verify the COC. It shall be verified that all weld filler metal is in compliance with MSFC-STD-655.

e. Products and their records shall show acceptance or nonconformance status when released from receiving inspection, and the products shall be protected for subsequent handling or storage. Nonconforming products shall be submitted for MRB action. Items awaiting inspection or test results shall be identified.

f. Sampling inspection shall be made of items such as nuts, bolts, and fasteners that are not used as critical attachments (paragraph 8.9).

g. Receiving inspection and test records shall be maintained, including copies of documents submitted by the supplier.

h. Assurance that the electrostatic discharge control plan (paragraph 8.12) is being complied with during receiving inspection.

8.10 FABRICATION CONTROL

8.10.1 Fabrication and Assembly Flow Plan

In addition to the general performance assurance requirements set forth in Section 1 (paragraphs 1.3 through 1.9), the contractor shall develop a Fabrication and Assembly Flow Plan that covers all operations (from start of fabrication to delivery), including the inspections and tests, GSI points, and all special processes to be used. A preliminary flow plan and a final flow plan shall be submitted in accordance with Attachment 2 of the contract.

8.10.2 Documentation

The contractor shall use a documentation system (consisting of items such as fabrication orders, assembly orders, shop travelers, and repair procedures) to control the flow of hardware through the manufacturing phase. Controls shall ensure that only the conforming product is released and used during fabrication and that those products not required for the operation involved are removed from the work area and properly stored. Traceability shall be maintained in accordance with paragraph 8.4. Fabrication documents shall include or reference:

a. Nomenclature and identification of the article

b. Tooling, jigs, fixtures, and other equipment to be used

c. Characteristics and tolerances to be obtained

d. Detailed procedures for controlling processes

e. Special conditions to be maintained, such as environmental conditions or precautions to be observed

f. Workmanship standards

g. Controls for parts, materials, and articles that have definite characteristics of quality degradation or drift with age, including requirements for recording and maintaining dates, time, or cycles for determining end of life

h. Traceability to the individual performing each fabrication and assembly operation

Contractor assurance personnel shall ensure that manufacturing operations are in compliance with up-to-date controlling documents.

8.10.3 Fabrication Requirements

The requirements of NHB 5300.4 (3A-1) [applicable to hardware fabricated prior to the award of the NOAA-N/N-prime contract modification], NHB 5300.4 (3A-2) [applicable to hardware fabricated after the award of the NOAA-N/N-prime contract modification], NHB 5300.4 (3G), NHB 5300.4 (3H), NHB 5300.4 (3I), NHB 5300.4 (3J), and NHB 5300.4 (3K) (Appendix A) shall be implemented. Workmanship standards may be used that show acceptance criteria. When display standards showing acceptance criteria are necessary, they will be jointly selected by the contractor and by Tiros or its quality representative. Standards shall be kept current and shall be used to train, certify, and recertify personnel who perform critical operations and operations that cannot befully verified without destructive disassembly or test.

8.10.4 Process Evaluation and Control

Controls shall be implemented for processes for which uniform high quality cannot be ensured by inspection of products alone. NDE methods may be used if controlled documentation and certified personnel are employed. Process procedures shall be prepared and shall describe the following:

a. Preparation of the processing equipment, solutions, and materials

b. Preparation of the products to be processed

c. Detailed processing operations

d. Conditions to be maintained during each phase of the process, including environmental controls

e. Methods of verifying the adequacy of processing materials, solutions, equipment, environments, and their associated

control parameters

f. Inspection and test provisions

g. Records for documenting the results of process inspection, test, and verification

The contractor shall provide for the certification of equipment used in selected processes. Records that certify test results shall be maintained. Equipment shall be recertified as indicated by the results of quality surveys, inspections, or tests, or when changes are made that may affect process integrity.

8.11 CONTAMINATION CONTROL REQUIREMENTS

Quality assurance personnel shall ensure compliance with the requirements of the Contamination Control Plan (Section 9) during all phases of the program.

8.12 ELECTROSTATIC DISCHARGE CONTROL

The contractor shall describe in the Implementation Plan (paragraph 1.3) the program to control Electrostatic Discharge (ESD) for electrical and electronic parts, assemblies, and equipment susceptible to damage caused by static electricity. The program shall address provisions for work area protection, handling procedures, training, intraplant protective covering, packaging for delivery, and Quality Assurance verification of conformance. The program shall provide for the identification and labeling of all ESD sensitive hardware and for the use of protective packaging and/or methods to reduce static charges so as to minimize the likelihood of ESD damage. The contractor shall also invoke applicable requirements for ESD control on subcontractors and suppliers.

8.13 NONCONFORMANCE CONTROL

The contractor shall operate a closed-loop nonconformance control system for failures and discrepancies. The system shall include provisions for the following:

a. Documentation of each nonconformance traceable to the specific product on which it occurred.

b. Assignment of a unique and traceable document number for each failure and for those discrepancies designated for Material Review Board (MRB) action.

c. Description of the nonconformance and the required characteristic or design criteria.

d. Conducting and documenting analyses and examinations to determine the cause.

e. Conducting and documenting timely and effective remedial and preventive action on the products and applicable documents.

f. Disposition of the nonconforming product.

g. Signatures of authorized personnel on the appropriate nonconformance documents.

h. Accumulating data in summary reports.

i. Performing analyses from the part level of assembly and higher to identify adverse trends and to provide for their correction.

j. Closeout of nonconformance documentation after verifying that effective remedial and preventive actions have been taken.

On request, a report of the analyses required by items d and i shall be made available to Tiros. Products that depart from specified requirements shall be identified and, if practicable, shall be isolated for review action. The system shall include provisions for controlling nonconforming products that cannot be isolated from the normal channels of manufacture.

If failure reporting is covered in the Reliability Section (Section 7) of the Implementation Plan, it shall describe how the responsibilities and procedures interface with the quality assurance activities. The discrepancy and failure-control sections of the plan shall be cross-referenced.

8.13.1 Control, Disposition, and Reporting of Discrepancies

8.13.1.1 Documentation

Control of discrepancies shall begin with the receipt of procured parts, materials, or other products or with the initiation of in-house manufacturing, whichever occurs first. Each discrepancy shall be documented on the appropriate contractor form as soon as it is discovered.

8.13.1.2 Initial Review Dispositions

Discrepant products shall be reviewed by contractor QA and, as appropriate, engineering personnel and shall be subjected to one of the following dispositions:

a. Return for Rework or Completion of Operations--The product shall be returned using established and approved documents and operations. During rework, the product shall be resubmitted to normal inspection and tests.

b. Scrap in Accordance with Government-Approved Contractor Procedures.

c. Return to Supplier--The contractor shall provide the supplier with the nonconformance information assistance that is necessary for remedial and preventive action.

d. Submit to Material Review Board--When the dispositions described above are not appropriate, the discrepant products shall be submitted to the MRB for final disposition.

Products disposed of without referral to the MRB shall be subject to review by the government quality representative. Initial review dispositions shall be recorded on nonconformance documentation.

8.13.1.3 Material Review Board

MRB decisions on nonconformance shall be submitted to Tiros in accordance with Attachment 2 of the contract. Other provisions of the MRB are as follows:

a. Membership--As a minimum, the MRB shall comprise the following members:

(1) Contractor quality representative (chairman)

(2) Contractor engineering representative

(3) Government quality representative

The contractor shall select members on the basis of technical competence. The government representative on the

board shall have review authority on board membership.

b. Responsibilities--The MRB shall have the responsibility to:

(1) Determine disposition of submitted products. Note that all MRB decisions must be unanimous.
(2) Ensure that remedial and preventive actions, including reinspection and retest requirements, are recorded on the nonconformance document before disposition.

(3) Perform trend analysis of discrepancies.

(4) Ensure that MRB records are maintained.

c. Dispositions--In addition to the dispositions listed in paragraph 8.13.1.2, the MRB shall have authority for the following:

(1) Repair--The MRB shall approve repairs, except as follows. Standard repair procedures shall be submitted to Tiros in accordance with Attachment 2 of the contract. The MRB shall authorize the use of the procedures for each instance of repair. The MRB shall ensure that the hardware reliability and quality are not compromised by excessive repairs. (See Note.)

(2) Scrap

(3) Use-As-Is--Submit a request in accordance with Attachment 2 of the contract except as follows (see Note):

(a) MRB disposition shall not adversely affect the safety, reliability, durability, performance, interchangeability, weight, or other basic features of the hardware.

(b) Dispositions that, in the opinion of the MRB, will adversely affect any of the foregoing or which are contrary to any of the requirements of the contract must be submitted as a waiver request to the contracting officer for approval in accordance with the project Configuration Management Plan (paragraph 8.3 and Attachment 2 of the contract).

Note: The products shall be withheld from further processing in a controlled area until direction for disposition is given by the contracting officer.

8.13.1.4 Supplier Material Review Board

With approval of Tiros or its authorized quality representative, the contractor may delegate MRB responsibility to suppliers.

8.13.2 Control, Reporting, and Disposition of Failures

8.13.2.1 Failure Reporting

A malfunction or failure report shall be written for any departure from design, performance, testing, or handling requirements that affect the function of a flight or ground segment or could possibly compromise mission objectives.

All other problems or anomalies that are unusual or that might affect other areas shall be cited on a malfunction or failure report.

Reporting of hardware failures shall begin with the first power application at the lowest level of assembly or the first operation of a mechanical item. For software items, use of this failure reporting system shall begin with the first test use of the software item with a hardware element of the mission system at the component level or higher. Reporting shall continue through

formal acceptance by the Tiros Project Office and the postlaunch operations, as required by the contract. Reporting of software problems occurring prior to initiation of software failure reporting as part of the mission system shall be in accordance with paragraph 8.20.

a. Report Processing--A malfunction or failure report shall be initiated immediately after the failure has occurred. (See Figures 8-1, 8-2, and 8-3 for a sample report form.)

The contractor may use his existing form for reporting if it complies with the requirements of the GSFC Malfunction Report form.

The report shall be submitted to Tiros in accordance with Attachment 2 of the contract, and the identical information shall be given to the in-plant government quality representative. The contractor shall maintain a master report file that contains all supplementary data, such as failure analysis and records of meetings.

b. Status Summaries--A summary of the open malfunction or failure reports shall be submitted as part of the Performance Assurance Status Report (paragraph 1.6). The summaries shall list each problem or failure as a separate line item and shall provide complete identification of the affected hardware (part and serial numbers), the environment, date of occurrence, and a brief description of the failure, its cause, and the corrective action to be taken.

8.13.2.2 Failure Review Board

A Failure Review Board (FRB) shall be established and, as a minimum, shall be comprised of the following:

a. Contractor quality representative (chairman)

b. Contractor project manager or his representative

c. Contractor engineering representative who is responsible for the failed item

d. Government or government authorized quality representative

The FRB shall investigate, analyze, and determine the cause of all failures. Investigations and actions shall be coordinated with Tiros and shall be documented on a malfunction or failure report. Trend analysis shall be performed, and corrective action shall be taken. When it is determined that the affected item is discrepant, the FRB will refer it to the MRB for disposition in accordance with paragraph 8.13.1.3. If required, configuration changes shall be in accordance with paragraph 8.3. Decisions of the FRB must be unanimous. Closeout of each failure shall require verification that remedial and preventive actions have been accomplished in the system hardware model on which the failure occurred, that necessary preventive design changes in hardware and software have been accomplished and verified in test, and that effectivity of preventive actions has been established in other existing identical items of hardware and software. The FRB chairman, denoting completion of closeout actions and approval of the entire Board, shall sign the malfunction or failure report closeout before submitting it to Tiros (Attachment 2 of the contract).

8.14 ALERT INFORMATION

Tiros shall provide the contractor with Alerts that document problems with parts, materials, processes, and safety as reported through the Government-Industry Data Exchange Program (GIDEP). In accordance with Attachment 2 of the contract, the contractor shall submit Responses to Alerts, which inform Tiros of the applicability of the problem to project hardware and any follow-up action proposed. Status summaries that cover each Alert received in a 30-day period shall be submitted as part of the Performance Assurance Status Report (paragraph 1.6).

Figure 8-1 GSFC Malfunction Report, Copy 1

Figure 8-2 GSFC Malfunction Report, Copy 4

Figure 8-3 Instructions for GSFC Malfunction Report

The contractor shall prepare Alerts on part, material, or manufacturing process problems that are within the scope of the Alert and safety system.

An Alert (Figures 8-4 and 8-5) must be prepared if during any phase of an item's life cycle after manufacturer's release, one of the following is evidenced:

a. A failure when operated within specification limits or within rating

b. A part design limitation when used within specified limits

c. An application limitation when used within specification limits

d. An unexpected incompatibility

e. An unexpected deterioration (degradation or contamination) when used within rating

f. Defective manufacturing process, inadequate quality inspection, handling, or sampling

g. An unsafe condition when used within specified rating, or within rating

h. Inadequate, incorrect, or easily misunderstood specifications lead to improper use of a part or material

Additionally, a Safe-Alert must be prepared to report significant safety problems in which loss of life, injury of personnel, or damage to or loss of property have or could have occurred.

8.15 INSPECTION AND TESTS

The contractor shall plan and conduct an inspection and test program for demonstrating that contract, drawing, and specification requirements are met. Inspections and tests shall be performed on products before they are installed in the next level of assembly. These inspections shall include a review of product records. Each inspection and test shall be traceable to the individual responsible. Quality assurance personnel shall approve all manufacturing documentation before it is used.

8.15.1 Planning

The contractor shall plan for inspections and tests and for a documentation system that substantiates their accomplishment. The planning function shall provide for:

a. Orderly and timely inspection and tests at the earliest opportunity and throughout all phases

b. Coordination and sequencing of inspection and tests conducted at successive levels of assembly to ensure satisfactory articles and materials and to eliminate unnecessary testing

c. Availability of handling equipment and calibrated inspection and test equipment

d. Coordination of inspections and tests conducted by the designated Government Quality Representative

8.15.2 Inspection and In-Process Test Procedures

Inspection shall be conducted in accordance with documented procedures physically located at the applicable inspection station. The degree of detail in the inspection procedure shall be commensurate with the complexity of inspection operations. Inspection procedures may be a part of the manufacturing control documentation. Procedures shall include, as applicable, the nomenclature of the article, characteristics to be inspected, accept/reject criteria, and special consideration regarding measuring equipment, standards, safety, and environment.

Figure 8-4 Alert Form

Figure 8-5 Instructions for Alert Form

8.15.3 Inspection Activity

As a minimum, the inspections in the following paragraphs shall be performed.

8.15.3.1 In-Process Inspection

In-process inspection shall be performed at all levels of assembly in keeping with the following requirements:

a. The configuration, drawing requirements, and workmanship shall be verified before the next step of fabrication or integration. Characteristics shall be verified that cannot be verified later without destructive disassembly.

b. In-process inspection shall be done in a clean environment in accordance with the Contamination Control Plan.

c. In-process inspection personnel shall be certified for selected processes and inspections.

d. In-process verification below the component level shall include electrical interface tests (paragraph 3.3.1) of subassemblies and assemblies prior to being integrated into the next higher level of hardware.

8.15.3.2 Final Inspection

Final inspection shall be performed at all levels of assembly as follows:

a. Configuration, workmanship, and test results shall be verified before installation or use with the next higher level of assembly.

b. Assurance personnel shall verify that all nonconformances have been processed and all open items have been transcribed into the next level of inspection or fabrication documents.

c. Same as 8.15.3.1(b).

d. Same as 8.15.3.1(c).

8.15.3.3 End-Item Inspection

End-item inspection shall be performed to:

a. Verify that configuration, test results, workmanship, and the Acceptance Data Package is in compliance with the contract.

b. Verify that Tiros has authorized the delivery of the end item with any open nonconformances and unresolved tasks that may exist.

8.15.3.4 Surveillance Inspection

Stored and stocked parts, materials, and flight or spare hardware shall be periodically inspected and tested for proper storage environment and packaging to prevent deterioration or damage. The contractor shall identify the hardware and the frequency of the inspection in the Implementation Plan.

8.15.3.5 Printed Wiring Board Inspections and Tests

Printed wiring boards shall conform to the requirements of NHB 5300.4 (3I), MIL-P-55110 (Appendix A), or a Tiros approved contractor specification, and shall be qualified by test and inspection results. Test coupons and test/inspection procedures shall be submitted to Tiros for evaluation upon request. NASA RP 1161, "Evaluation of Multilayer Printed

Wiring Boards by Metallographic Techniques" (Appendix A), is recommended as a guide to the performance of these tests and to the interpretation of the test results.

8.15.4 QA Activities During Integration and Test Phase

Assurance personnel shall ensure that the subassemblies, assemblies, components, and contract end-items are integrated and tested in accordance with controlling documents. Articles undergoing test shall not be adjusted, modified, repaired, reworked, or replaced except as specified in established documents, or in accordance with MRB actions. The status, configuration, and integrity of the hardware must be maintained and documented. Test activities shall be conducted in a clean area in accordance with the Contamination Control Plan.

Assurance personnel shall provide surveillance of all tests, the extent of which shall be defined in QA and test documents by quality assurance management. As a minimum, the activities in the following paragraphs shall be performed.

8.15.4.1 Verification

Before testing, the assurance personnel shall verify:

a. The presence of approved inspection and test documents

b. The identification of products

c. The configuration of products

d. That test equipment is within the calibration period for the duration of the test

e. Test setup and test configuration

8.15.4.2 Test Documentation

During tests, the assurance personnel shall:

a. Ensure that tests are conducted in accordance with approved specifications and procedures.

b. Ensure accurate and complete recording of data and results.

c. Document rework, repairs, or modifications.

d. Document nonconformances.

8.15.4.3 Post-Test Assurance Activity

Subsequent to testing, the assurance personnel shall:

a. Verify by visual inspection that tested articles are not damaged or deteriorated as a result of testing.

b. Ensure proper disposition of articles.

c. Verify that test results, reports, and nonconformance documents are accurate, complete, and traceable to the tested products. Any additional nonconformances shall be processed in accordance with paragraph 8.13.

8.15.5 Inspection and Test Records (Component Level to End-Item)

8.15.5.1 General Requirements

The contractor shall prepare and maintain records, including logs, of all inspections and tests to show that all operations have been performed, that objectives have been met, and that end-items have been fully verified.

8.15.5.2 Scope

Records shall cover each component, subsystem, and system. As the hardware is integrated, records of lower-level assembly products shall be combined into those for the end-item as a means of compiling a continuous chronological history of identified hardware, fabrication, assembly, inspection, and tests, as well as other actions or data important to a complete assurance record, such as idle periods (storage), movement of the end-item, repairs, approvals, maintenance, and configuration data.

Assurance personnel shall verify that records are complete. The records shall be retained at the contractor's plant as prescribed by the contract.

8.16 CONFIGURATION VERIFICATION

Assurance personnel are required to verify that the as-built product complies with the applicable as-designed configuration listing and that it is in accordance with approved configuration documents as required by the Configuration Management Plan and with paragraphs 8.3, 8.4, and 8.20. The configuration shall be maintained and controlled throughout the program.

8.17 METROLOGY

8.17.1 General Requirements

The contractor shall establish and comply with a documented metrology system for ensuring that measurement standards and equipment are selected and controlled to the degree necessary to meet drawing requirements. The system shall be in accordance with the provisions of MIL-STD-45662 (Appendix A).

8.17.2 Instruments Used for Measuring

Tools, gages, jigs, and fixtures for measuring dimensions, contours, or locations that affect quality characteristics shall be checked for accuracy before use. Checks and recalibrations shall be made at predetermined intervals to ensure continued accuracy.

8.17.3 Product Measurement Processes

Random and systematic errors in any article or material measurement process shall not exceed 10 percent of the tolerance or material characteristics being measured. When state of the art or other considerations make this provision impossible or impracticable, the contractor shall maintain a list of those exceptions, and they shall be available for review upon request.

8.17.4 Calibration Measurement Processes

Random and systematic errors in any calibration measurement process shall not exceed 25 percent of the tolerance of the parameter being measured. When state of the art or other considerations make this provision impossible or impracticable, the contractor shall maintain a list of those exceptions, and they shall be available for review upon request.

8.18 STAMP CONTROL SYSTEM

The contractor shall establish and maintain a documented stamp control system that provides the following:

a. Stamps, decals, seals, and paints shall comply with the criteria of paragraph 6.2.4 and shall show that products have undergone source and receiving inspection, in-process fabrication and inspection, end-item fabrication, inspection and storage, and shipment.

b. Stamps shall be traceable to the individual responsible for their use, and records shall be maintained to identify the individual. Fabrication (manufacturing) and inspection stamps shall be of different designs.

c. Stamps shall be applied to records to indicate the fabrication or inspection status of the products.

8.19 SAMPLING PLANS

Sampling plans may be used when inspections or tests are destructive or when data, inherent characteristics, or noncritical application of a product permits a reduction in inspection or testing. Such plans shall not jeopardize quality, reliability, or design intent. MIL-STD-105 (Appendix A) shall be used for establishing the sampling plan requirements. The sampling plan shall provide an average quality level that is appropriate to the reliability requirements of the project. Sampling plans shall be identified in the applicable inspection procedures.

8.20 TRAINING AND CERTIFICATION FOR MANUFACTURING AND INSPECTION PERSONNEL

8.20.1 Training

The contractor shall use trained personnel for implementing theperformance assurance program and processes control. Training programs shall be developed, documented, implemented, and maintained for personnel who may have an effect on or who are responsible for reliability and quality.

8.20.2 Certification and Recertification of Personnel

a. Certification--Contractor personnel who control selected processes or perform selected operations such as soldering, module welding, potting, encapsulation, and radiography shall be certified on the basis of evidence of competence that includes training and testing.

b. Recertification--Contractor personnel shall be recertified if they fail to perform satisfactorily in producing products or services, if changes occur in techniques or required skills, or if their work experience as established for the process or operation is interrupted. Recertification shall require retesting of the individual to demonstrate proficiency. Persons who fail the retest shall not perform the tasks until they receive additional training and proficiency has been demonstrated.

8.20.3 Records

Records shall be maintained of the training, testing, certification, and recertification status of personnel.

8.21 HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

The contractor shall write and implement procedures for the handling, storage, preservation, marking, labeling, packaging, packing, and shipping of all products. These procedures shall be submitted in accordance with Attachment 2 of the contract

and shall implement the requirements of NHB 6000.1 (Appendix A) and the following paragraphs.

8.21.1 Handling

The protection of products during the life of the program shall be achieved through the use of handling equipment and techniques that have been certified before use. Evidence of initial and periodic proof-testing of handling equipment shall be maintained.

8.21.2 Preservation, Marking, Labeling, Packaging, and Packing

Products shall be stored, preserved, marked, labeled, packaged, and packed to prevent deterioration, contamination, or damage during all phases of the program. Stored and stocked items shall be controlled in accordance with documented procedures and be subject to quality surveillance as stated in paragraph 8.15.3.4.

8.21.3 Shipping

Prior to shipping, the contractor shall ensure that:

a. Fabrication, inspection, and test operations have been completed and accepted.

b. All products are identified and marked in accordance with requirements.

c. The accompanying documentation (contractor's shipping and property accountable form) has been reviewed for completeness, identification, and quality approvals.

d. Evidence exists that preservation and packaging requirements have been complied with.

e. Packaging and marking of products, as a minimum, comply with Interstate Commerce Commission rules and regulations and are adequate to ensure safe arrival and ready identification at their destinations.

f. The loading and transporting methods are in compliance with those designated in the shipping documents.

g. Integrity seals have been placed on shipping containers.

h. In the event of unscheduled removal of a product from its container, the extent of reinspection and retest shall be as authorized by Tiros or its representative.

i. Special handling instructions for receiving activities are provided where appropriate.

The contractor's quality assurance organization shall verify prior to shipment that the above requirements have been met. QA shall sign off appropriate shipping documents to provide evidence of this verification.

8.22 GOVERNMENT PROPERTY CONTROL

8.22.1 Contractor's Responsibility

In accordance with the provisions of the contract, the contractor shall be responsible for and shall account for all property supplied by the government, including government property that may be in the possession or control of a supplier. The contractor's responsibility shall include, but not be limited to, the following:

a. On receipt, examination of products to detect damage that may have occurred in transit.

b. Inspection for quantity, completeness, proper type, size, and grade as specified in the shipping documents.

c. Provision for the protection, maintenance, calibration, periodic inspection, segregation, and controls necessary for preventing damage or deterioration during handling, storage, installation, or shipment.

d. Maintenance of records that include:

(1) Identification of the property

(2) Location of the property

(3) Dates, types, and results of contractor inspections, tests, and other significant events

e. Any functional tests on the product that are directed by the Tiros Project Office.

8.22.2 Unsuitable Government Property

The property shall be processed in accordance with government procedures and paragraph 8.13. The property shall not be dispositioned, repaired, reworked, replaced, or in any way modified unless such action is authorized by the contract or by the contracting officer in writing.

8.23 GOVERNMENT ACCEPTANCE

Before acceptance by Tiros, contractor quality assurance personnel shall ensure that deliverable contract end-items, including the Acceptance Data Package, are in accordance with contract requirements. A copy of the data package shall be submitted to Tiros in accordance with Attachment 2 of the contract, and a copy shall accompany each end-item.

8.24 ATNAGE PERFORMANCE ASSURANCE REQUIREMENTS

The contractor shall prepare and submit a separate Performance Assurance Plan applicable to the repair, maintenance, operation, and calibration of Advanced TIROS-N Aerospace Ground Equipment (ATNAGE). The contractor may base this plan upon existing sections of 2303081 "Quality Assurance Program Plan for TIROS," as it applies to AGE only.

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9. CONTAMINATION CONTROL REQUIREMENTS

9.1 APPLICABILITY AND DEFINITIONS

This section provides requirements for meeting the contamination control needs of a project; it is applicable to the spacecraft and its elements. Contaminants are defined as those materials, either at a molecular or a particulate level, whose presence degrades mission performance.

9.2 CONTAMINATION CONTROL PLAN

The contractor shall prepare and implement a Contamination Control Plan (CCP), utilizing FED-STD-209 (Appendix A) as a guide, that includes contamination allowances, methods for control, and verifications that the goals have been met. At least one copy of all referenced analyses, procedures, standards, and specifications, except for government standards, shall be provided with the CCP. The plan shall be submitted in accordance with Attachment 2 of the contract.

9.2.1 Contamination Allowance

As a basis for contamination control activities, the contractor shall establish a contamination allowance for performance degradation of contamination-sensitive hardware such that, even in the degraded state, the hardware will meet its mission objectives. The allowance and the rationale for its selection shall be delineated in the CCP and shall serve as a basis for the measures to be taken to control contamination.

9.2.2 Contamination Control

The contractor shall delineate in the CCP the measures to be taken for controlling contamination so that the contamination allowance established in paragraph 9.2.1 is not exceeded and for verifying that the performance degradation limits established under paragraph 9.2.1 have not been exceeded. The measures shall include the implementing and controlling documentation that describes the methods for measuring and maintaining the levels of cleanliness required during the various phases of the hardware lifetime. The documentation shall include criteria for defining out-of-control conditions and ways of dealing with them. The CCP shall contain analyses that show how the controls will result in meeting the contamination allowance and such verifications as are necessary for demonstrating that the performance degradation limits have not been exceeded.

The CCP shall include, in a separate section, those contamination controls to be exercised in preparing the thermal-vacuum chamber and the necessary fixtures and stimuli for system level tests. It shall also include those operational procedures that will be followed to minimize the contamination hazard, from pumpdown through return to ambient conditions. Test phases that represent contamination hazards and the approaches to be taken to minimize these hazards shall be addressed. Pretest measurements, monitoring methods to be used during the test, and post-test measurements for verifying that contamination criteria have not been exceeded shall be discussed. Contingency plans dealing with the possibility that contamination criteria are exceeded shall be included.

To the extent necessary to meet mission requirements; solar arrays, major wiring harnesses, and thermal blankets shall be baked-out.

Because they can be a source of contamination, special consideration shall be given to materials and equipment used in cleaning, handling, and packaging flight hardware.

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10. SOFTWARE ASSURANCE REQUIREMENTS

10.1 GENERAL REQUIREMENTS

The contractor shall establish an organized program of software assurance that includes performance verification, quality assurance, configuration management verification, and nonconformance reporting and corrective action. The program shall be coordinated with the hardware and systems oriented program established to meet the requirements of the rest of this document. Data deliverable to Tiros are listed in Attachment 2 of the contract.

The contractor shall prepare a Software Performance Assurance Implementation Plan (SPAIP), as part of the Implementation Plan (paragraph 1.3), that indicates how the requirements of this section shall be met.

The developer shall provide to Tiros monthly reports on assurance actions taken compliant to the provided SPAIP. This report shall be part of the monthly Performance Assurance Status Report (paragraph 1.6).

10.2 PERFORMANCE VERIFICATION

This section of the SPAIP shall describe the methods and general tests to be used by the developer to demonstrate that the software is correct and meets its requirements. These methods shall include a set of internal and external reviews. The developer's internal reviews shall consist of status reviews and technical reviews, including some form of design and code walk-throughs.

External reviews shall consist of one or more design reviews and a system test readiness review. The purpose of each of the reviews is to demonstrate that the associated phase of the software development process is complete and that the development process was correct. Therefore, each review shall be scheduled before significant activity is underway on a subsequent phase, and the questions raised at the review shall be resolved before such activity begins. The reviews shall consist of a presentation by the developer to a review panel appointed by Tiros with backup material, splinter sessions, and subsequent meetings as required to resolve any raised issues.

The developer shall produce a test plan that shows how the software is to be tested. The test plan shall show the tests to be run to satisfy the software requirements, the data needed to run the tests, any special software (simulators, etc.) needed for the testing, and any required support from other organizations to do the testing. The first version of the test plan shall be available for review by Tiros before the system PDR (paragraph 2.3).

10.3 QUALITY ASSURANCE

The contractor shall have a quality assurance program that includes the assurance that standards are met and procedures are carried out. The developer shall set standards for the documentation listed in section one of this SPAIP for the internal code level documentation, the documentation of software designs for interface specifications, and for code.

The developer shall have procedures that when carried out implement the performance verification, configuration management, and nonconformance reporting and corrective action plans given in the other sections of the SPAIP.

The developer shall have an assurance function that verifies that the procedures have been followed, that action items have been completed, and that status is as reported.

10.4 CONFIGURATION MANAGEMENT

The contractor shall establish and document in this section of the SPAIP a configuration management review process to monitor compliance to configuration management policies in software managing requirements, design, code, documentation, and data, and to track and report on the status of any changes. The process shall, as a minimum, establish three baselines and set formal, documented approval processes for changes to the baselines. The established procedures shall include a process

for requesting Tiros approval for any changes that will affect the project schedule, cost, function, or external interfaces.

10.5 NONCONFORMANCE REPORTING AND CORRECTIVE ACTION

The contractor shall establish and document in this section of the SPAIP processes and procedures for the reporting, analysis, and correction of nonconformances discovered in the software and documentation. The system shall interface with the configuration management system such that change control is effected and so that reported nonconformances that are in reality change requests are so identified and processed. The developer shall provide a reporting system that shows the status and criticality of all nonconformances.

APPENDIX A

APPLICABLE DOCUMENTS

Paragraph No.	Document No.	Title	Available From
		Section 1	
1.1	NHB 5300.4(1A)	Reliability Program Provisions for Aeronautical and Space System Contractors	See Note 4
1.1	NHB 5300.4(1B)	Quality Program Provisions for Aeronautical and Space System Contractors	See Note 4
		Section 2	
2.5	S-311-98A	Guidelines for Conducting a Packaging Review	Tiros Project Off
		Section 4	
4.1	WSMCR 127-1	Western Space and Missile Center Safety Requirements, Range Safety Regulation	Tiros Project Off
4.1	MIL-STD-1574A	System Safety Program for Space and Missile System	See Note 4
		Section 5	
5.2.1	GSFC PPL 18	GSFC Preferred Parts List	Tiros Project Off
5.2.1	MIL-STD-975F	NASA Standard Electrical, Electronic, and Electromechanical (EEE) Parts List	See Note 4 or 5
5.2.2.b	S-311-200	General Requirements for Hybrid Microcircuits	Tiros Project Off
5.2.4	MIL-STD-490A	Specification Practices	See Note 4 or 5
5.2.6	S-311-70	GSFC Specification--Construction Analysis of Electronic Parts	Tiros Project Off
		Section 6	
6.2.1	None	GSFC Materials Tips for Spacecraft Applications	Tiros Project Off
6.2.1	TM 82275[1] (GSFC Mtr. No. 755-013)	Quality Features of Spacecraft Ball-bearing Systems	See Note 6
6.2.1	TM 82276[1] (GSFC Mtr. No. 313-003)	An Evaluation of Liquid and Grease Lubricants for Spacecraft Applications	See Note 6
6.2.1	N-75-24848[1] (SP-3094)	Spacecraft Materials Guide	See Note 6
6.2.1	N-80-30441[1] (NASA RP-1061)	An Outgassing Data Compilation of Spacecraft Materials	See Note 6

NTIS (Note 6) Accession Numbers: Documents can be ordered individually from NTIS by these numbers.

6.2.1	NASA/JSC 09604/MSFC HDBK 527	Compilation of Volatile Condensable Materials Data of Nonmetallic Materials	See Note 1
6.2.1	JSC 09604 with Addendum 1	List of Materials that meet JSC Vacuum Stability Requirements	See Note 1
6.2.4	ASTM E595-77	Standard Test Method for Total Mass Loss and Collected Volatile Condensable Material from Outgas in a Vacuum Environment	See Note 8
Section 8			
8.5.8	MSFC-STD-655	Standard Weld Filler Metal, Control of	See Note 7
8.10.3	NHB 5300.4(3A-1)	Requirements for Soldered Electrical Connections	See Note 4
8.10.3	NHB 5300.4(3G)	Requirements for Interconnecting Cables, Harness, and Wiring	See Note 4
8.10.3	NHB 5300.4(3H)	Requirements for Crimping and Wire Wrap	See Note 4
8.10.3	NHB 5300.4(3I)	Requirements for Printed-Wiring Boards	See Note 4
8.10.3	NHB 5300.4(3J)	Requirements for Conformal Coating and Staking of Printed-Wiring Boards and Electronic Assemblies	See Note 4
8.10.3	NHB 5300.4(3K)	Design Requirements for Rigid Printed-Wiring Boards and Assemblies	See Note 4
8.15.3.5	MIL-P-55110C	General Specification for Printed-Wiring Boards	See Note 5
8.15.3.5	NASA RP 1161	Evaluation of Multilayer Printed-Wiring Boards by Metallographic Techniques	See Note 2
8.17.1	MIL-STD-45662 Notice 3	Calibration System Requirements	See Note 5
8.19	MIL-STD-105D Notice 2	Sampling Procedures and Tables for Inspection by Attributes	See Note 5
8.21	NHB 6000.1C	Requirements for Packaging, Handling, and Transportation	See Note 4
Section 9			
9.2	FED-STD-209B	Federal Standard Clean Room and Work Station Requirements, Controlled Environment	See Note 5

NOTES (Sources):

1. NASA/Lyndon B. Johnson Space Center, Publication Control Office, Houston, TX, 77058.
2. NASA/Scientific and Technical Information Facility, P.O. Box 8757, BWI Airport, MD, 21240.
3. NASA/John F. Kennedy Space Center, Publication Control Office, Kennedy Space Center, FL, 32899.
4. Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402.
5. Department of the Navy, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA, 19120.
6. National Technical Information Service, Springfield, VA, 22161.
7. NASA/George C. Marshall Space Flight Center, Marshall Documentation, Huntsville, AL, 35812.
8. American Society for Testing Materials, 1916 Race Street, Philadelphia, PA, 19103.

APPENDIX B

GLOSSARY

Acceptance Tests--The process that demonstrates that hardware is acceptable for flight. It also serves as a quality control screen for detecting deficiencies and normally for providing the basis for delivery of an item under terms of a contract.

Assembly--A functional subdivision of a component, consisting of parts or subassemblies that perform functions necessary for the operation of the component as a whole (e.g., a power amplifier and gyroscope.)

Audit--A review of the contractor's or subcontractor's documentation or hardware to verify that it complies with project requirements.

Box, Electronic--See "Component."

Collected Volatile Condensable Material (CVCM)--The quantity of outgassed matter from a test specimen that condenses on a collector maintained at a specific constant temperature for a specified time. CVCM is expressed as percentage of the initial specimen mass.

Component--A functional subdivision of a subsystem and generally a self-contained combination of items performing a function necessary for the subsystem's operation (e.g., transmitter, gyro package, actuator, motor, and battery.)

Configuration--The functional and physical characteristics of parts, assemblies, equipment of systems, or any combination of these that are capable of fulfilling the fit, form, and functional requirements defined by performance specifications and engineering drawings.

Configuration Control--The systematic evaluation, coordination, and formal approval/disapproval of proposed changes and implementation of all approved changes to the design and production of an item, the configuration of which has been formally approved by the contractor, by the purchases, or by both.

Configuration Management--The systematic control and evaluation of all changes to baseline documentation and subsequent changes to that documentation that define the original scope of effort to be accomplished (contract and reference documentation) and the systematic control, identification, status accounting, and verification of all configuration items.

Derating--The reduction of the rating of a device to improve reliability or to permit operation at high ambient temperatures.

Design Specification--Generic designation for a specification that describes functional and physical requirements for an article, usually at the component level or higher levels of assembly. In its initial form, the design specification is a statement of functional requirements with only general coverage of physical and test requirements. The design specification evolves through the project life cycle to reflect progressive refinements in performance, design, configuration, and test requirements. In many projects, the end-item specifications serve all the purposes of design specifications for the contract end-items. Design specifications provide the bases for technical and engineering management control.

Designated Representative--An individual (such as a NASA plant representative), firm (such as assessment contractor), Department of Defense (DAD) plant representative, or other government representative designated and authorized by NASA to perform a specific function for NASA. As related to the contractor's effort, this function may include evaluation, assessment, design review participation, and review/approval of certain documents or actions.

Destructive Physical Analysis (DA)--An internal destructive examination of a finished part or device to assess design, workmanship, assembly, and nay other processing associated with fabrication of the part.

Discrepancy--See "Nonconformance."

Electromagnetic Compatibility--The condition that prevails when various electronic devices are performing their functions according to design in a common electromagnetic environment.

Electromagnetic Interference (EMI)--Electromagnetic energy that interrupts, obstructs, or otherwise degrades or limits the effective performance of electrical equipment.

Electromagnetic Susceptibility--Undesired response by a component, subsystem, or system to conducted or radiated electromagnetic emissions.

End-to-End Tests--Tests performed on the integrated ground and flight system, including all elements of the spacecraft, its control, communications, and data processing to demonstrate that the entire system is operating in a manner that will fulfill all mission requirements and objectives.

Failure--See "Nonconformance."

Failure Modes, Effects, and Criticality Analysis (FMECA)--Study of a system and working interrelationships of its elements to determine ways in which failures can occur (failure modes), the effects of each potential failure on the system element in which it occurs and on other system elements, and the probable overall consequences (criticality) of each failure mode on the success of the system's mission. Criticalities are usually assigned by categories, each category being defined in terms of a specified degree of loss of mission objectives or degradation of crew safety.

Functional Tests--The operation of a unit in accordance with a defined operational procedure to determine whether performance is within the specified requirements.

Hardware--As used in this document, there are two major categories of hardware as follows:

1. Prototype Hardware--Hardware of a new design; it is subject to a design qualification test program; it is not intended for flight.

2. Flight Hardware--Hardware to be used operationally in space. It includes the following subsets:

   a. Protoflight Hardware--Flight hardware of a new design; it is subject to a design qualification test program.

   b. Follow-on Hardware--Flight hardware built in accordance with a design that has been qualified either as prototype or as protoflight hardware; follow-on hardware is subject to a flight acceptance test program.

   c. Spare Hardware--Hardware whose design has been proven in a design qualification test program; it is subject to a flight acceptance test program and is used to replace flight hardware that is no longer acceptable for flight.

   d. Reflight Hardware--Flight hardware that has been used operationally in space and is to be reused in the same way; the verification program to which it is subject depends on its past performance, current status, and the upcoming mission.

Inspection--The process of measuring, examining, gaging, or otherwise comparing an article or service with specified requirements.

Instrument--A subsystem consisting of sensors and associated hardware for making measurements or observations in space.

Margin--The amount by which hardware capability exceeds requirements.

Mission Allowable Temperatures--The mission allowable temperature limits shall encompass those temperatures experienced during the mission and during system-level thermal balance testing.

The relationship between mission allowable, acceptance, and qualification temperatures is as follows:

+10°C		
+ 5°C		
MISSION ALLOWABLE AND ACCEPTANCE TEMPERATURE LIMITS	QUALIFICATION TEMPERATURES (PASSIVE THERMAL CONTROL)	QUALIFICATION TEMPERATURES (ACTIVE THERMAL CONTROL)
-5°C		
-10°C		

Monitor--To keep track of the progress of a performance assurance activity; the monitor need not be present at the scene during the entire course of the activity, but he will review resulting data or other associated documentation. (See "Witness.")

Nonconformance--A condition of any hardware, software, material, or service in which one or more characteristics do not conform to requirements. As applied in quality assurance, nonconformances fall into two categories:

1. Discrepancy--A discrepancy is a departure from specification that is detected during inspection or process control testing, etc., while the hardware or software is not functioning or operating.

2. Failure--A failure is a departure from specification that is discovered in the functioning or operation of the hardware or software.

Part--A hardware element that is not normally subject to further subdivision or disassembly without destruction of designed use.

Payload--An integrated assemblage of subsystems designed to perform a specified mission in space.

Performance Verification--Determining by test, analysis, or a combination of the two that the spacecraft element can operate as intended in a particular mission; this verification includes ensuring that the design of the spacecraft or element has been qualified and that the particular item has been accepted as true to the design and ready for flight operations.

Prototype Hardware--See "Hardware."

Qualification--The process of demonstrating that a given design and manufacturing approach will produce hardware that will meet all performance specifications when subjected to defined conditions more severe than those expected to occur during its intended use.

Redundancy (of design)--The use of more than one independent means of accomplishing a given function.

Repair--The article is to be modified by established (customer-approved when required) standard repairs or specific repair instructions that are designed to make the article suitable for use but that will result in a departure from the original specification.

Rework--Return for completion of operations (complete to drawing). The article is to be reprocessed to conform to the original specifications or drawings.

Similarity, Verification By--A procedure of comparing an item to a similar one that has been verified. Configuration, test data, application, and environment should be evaluated. It should be determined that design differences are insignificant, that

environmental stress will not be greater in the new application, and that manufacturer and manufacturing methods are the same.

Single-Point Failure--A single element of hardware, the failure of which would result in loss of mission objectives, hardware, or crew, as defined for the specific application or project for which a single-point failure analysis is performed.

Spacecraft--An integrated assemblage of components designed to perform a specific mission in space.

Subassembly--A subdivision of an assembly (e.g., wire harness and loaded printed-circuit boards).

Thermal Balance Test--A test conducted to verify the adequacy of the thermal design and the capability of the thermal control system to maintain thermal conditions within established mission limits.

Total Mass Loss (TML)--Total mass of material outgassed from a specimen that is maintained at a specified constant temperature and operating pressure for a specified time. TML is expressed as a percentage of the initial specimen mass.

Vibroacoustics--An environment induced by high-intensity acoustic noise associated with various segments of the flight profile; it manifests itself throughout the payload in the form of directly transmitted acoustic excitation and as structure-borne random vibration excitation.

Witness--A personal on-the-scene observation of a performance assurance activity with the purpose of verifying compliance with project requirements (See "Monitor.")